THE

ELECTRICAL REVIEW.

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THE BATTLE OF THE ENGINEERS.

IT cannot be said that the present appearances of the great engineering struggle favour a cessation of hostilities. The employers are knit together in a solid phalanx, which from day to day grows more formidable. Nor are there any marked signs of weakening on the part of the members of the Amalgamated Society of Engineers. They have been no doubt duly impressed with the tremendous force arrayed against them, but capitulation is not easy to those who commence hostilities. There is no denying the fact that labour has in the past gained many notable victories, and few men would be inclined to under-rate the righteousness and justice of many of those victories, but the history of warfare shows that an uninterrupted series of triumphs breeds in the conquerors a spirit of arrogance, and it need not, therefore, be surprising to find that, as labour advances from one advantageous position to another, it becomes somewhat overbearing in its demands. On all questions that have hitherto vitally affected the welfare of the organised workers, labour has gained handsome concessions, and their success in previous agitations had been so marked, that they overlooked the virtue of moderation. The Amalgamated Society entered upon the present conflict with so much complacency, as to lead one to think that they were under the impression the matter would never be seriously contested. There never was a more serious mistake made in the history of industrial agitation; the gage of battle was taken up by the employers with a determination that was staggering to the leaders of the Amalgamated Society. It was evident at the commencement of hostilites that the Amalgamated Society were not prepared for the campaign to be conducted on so wide a base; they had apparently relied on a system of guerilla warfare, and were unprepared to meet the marshalled forces of the combined employers.

One may hesitate to accept the present dispute as a microcosm of the war that we are told will one day be waged between capital and labour; but however that may be, the representatives of capital have, through the present strife, learned some of the fundamental principles of warfare. They have realised to the full the advantages of organisation, and as defenders, they have gained material points by delivering counter attacks upon the positions of the men.

The present struggle, which is shaking the engineering industries of this country to their foundations, is not based on a protest against iniquitous conditions of labour: the men are not fighting against a low standard of wage, nor are they combining for the right to live decently. They are well paid, their workshops are generally light and healthy, and a paternal Government sees that if they come to harm through the fault of the employer, the blame is duly apportioned. The mechanic occupies a much higher social position than he did 40 years ago; his hours of labour are shorter, he lives in healthier dwellings, he is provided with free libraries, he has the privilege of obtaining free education for his children, mainly at the expense of other classes of the community; and, moreover, he has an influence in the government of the country. But the engineers want more than this; they seek

ostensibly to work shorter hours, and, apparently, they desire to have a voice in the question of management and production. Are the members of the Amalgamated Society, in their humane crusade, interested in the general welfare of workers outside the engineering circle? Do the conditions of labour under which thousands of men and women are groaning to-day appeal to them? We venture to say that beyond themselves they do not betray the slightest interest in the industrial population; yet we are told that the present action of the engineers is but a step towards an improved social state. If the highly trained and intelligent workmen were raising the standard of revolt against the chain-making industries which bind hundreds of women in hideous slavery, or the nail making trades, which grind men and women to death with the remorselessness of a Juggernaut, then no honest man's sympathy could be withheld.

If the engineering workman thinks he is helping towards Utopia by persisting in his present line of conduct he is acting under a sheer delusion, and it is a delusion which, if not dispelled, will bring unparalleled misery in its train. Even supposing we have reached a stage where the great battle is to be fought between capital and labour, then the workman of the present day, as well as the trade of this country, is going to be ground exceeding small. It cannot be claimed that the present position is creditable to the intelligence of the working man; moreover, it must be said to his everlasting discredit that he has been guilty of offences against common honesty. If an employer of labour employs a machine to do certain work, and the workman seeks to deprive that machine of its labour-saving value, it constitutes an insidious attack upon the owner's purse. Tampering with a machine tool in order to lessen its efficiency is an insult to the workman's skill and an injury to the well being of the employer. We want more common honesty in the relationship between employer and men, for at the present time there exists too much distrust. Yet is it surprising that an atmosphere of suspicion surrounds the actions of the men. They have followed certain definite instructions from headquarters to run machines slow, and in other ways to lessen the production of each man; and with these facts clearly established, it is not to be wondered at that employers should decline to have association with the labour leaders, much less to negotiate terms upon which the men will return to their work. The workmen are amazing in their shortsightedness. They work a machine slow in order to put a limit on production, forgetting the all important fact that the more rapidly we are able to turn out work, the easier can we compete with foreign manufacturers and get fresh orders in hand; for in spite of the bombastic rhetoric of the labour speakers, foreign competition is a very real thing. The members of the Amalgamated Society of Engineers are living in a fool's paradise, and in a few short months they may find themselves in the position of Othello. The fact cannot be blinked that in electrical manufacturing shops at least, unionists are being replaced by free labour men, and the immediate result is that the production per man has materially increased.

The unreliability of labour is fast becoming an established fact in the industries of this country, and it need scarcely be a matter for surprise that the recognition of this condition by the masters should result in manufacturing being transferred to countries where labour troubles are less acute.

It is to be sincerely hoped that the masters will persist in their present dignified policy of resistance, not forgetting the fact that the occasion demands the exercise of much patience and statesmanship. When public sympathy might be alienated by a mere phrase, it behoves the employers to put a rein on their tongue; "for who talks much, must talk in vain."

The present deadlock is one of the most lamentable events that has darkened the industries of this country for many years, and it almost passes the wit of man to know how the breach is to be healed. We are not lacking in sympathy for the working man, and especially for those who are dependent upon him for their daily bread, and who receive but scant consideration from those who are responsible for the too frequent misunderstandings between the representatives of capital and labour, but it does seem to us that right and truth is on the side of the employers in the present conflict. The men are hampered in their operations by having at the outset obscured the real issue; and no doubt the confusion surrounding the question at issue accounts in some measure for the curious aloofness of the public that has marked the present dispute. Whatever happens, the close of the engineering strike will bring irrecoverable exhaustion to the combatants, and irreparable damage to the engineering trade of the country.

Effect of Alternating Currents on the Human Body.

In the *Electrotechnische Zeitschrift*, October 7th, a series of interesting experiments made by Prof. Weber, of Zurich, to determine the risks incurred from accidental contact with live tramway conductors, is described. The experiments were made on his own body, and were divided into two groups. In the first group two bare conductors of opposite potential were grasped firmly with wet and dry hands. The periodicity of the currents was 50. With a D.P. of 30 volts, and with damp hands, the fingers, hand, wrist, lower and upper arm felt as if they were paralysed, the fingers could scarcely be moved, and the hand could scarcely be turned. The straightened arm could not be bent, and the bent arm could not be straigtened. Very lively pains were felt in the fingers, hands, and arms. The pain could not be endured for longer than 5 to 10 seconds. It was still, however, possible by a strong exertion of will to let go the wires. The current flowing through the body was found to be 12 to 15 milli-amperes. When the D.P. amounted to 50 volts, all the muscles of the fingers, hands, and arms were temporarily paralysed, at the moment when the conductors were grasped by the damp hands. It was found impossible to let go the wires by the greatest exertion of will. The pain was so great that it could not be endured for longer than 1 to 2 seconds; for this reason no measurement of the current could be made. With a P.D. of 90 volts and dry hands, the hands were for the moment completely paralysed, the wires could not be let go, and the pains in the hands and arms were so great that the observer involuntarily cried out. The pain could not be endured for longer than 1 to 2 seconds. Mr. Charles Brown made similar experiments on himself, and found that in his case it required about double the P.D. to produce the same phenomena. Though these highly disagreeable effects were experienced with tensions which exist in every house installation, it does not prove that such installations are necessarily dangerous. An accidental contact is never likely to be so thorough as the grasping of two bare wires with the hands, and no case is recorded of personal injury having been done by a house installation. The second group of Prof. Weber's experiments were made with the view of determining the injury that was likely to be done to a person standing on the ground and touching a live alternating conductor. When the observer stood on a wet macadamised road and grasped a 2,000 volt conductor, only a strong burning sensation was felt. When the grip on the conductor was tight a violent trembling of the finger muscles was felt. Standing on clay soil covered with moistened coal dust, the observer felt a burning like fire when he placed his hand on a 1,300 volt conductor; when the conductor was firmly grasped the fingers and hand were temporarily paralysed and the conductor could not be let go. In these experiments the observer's boots were dry, and the safety of the observer evidently resulted from the insulating properties of good dry shoe leather. Prof. Weber has reported to the Swiss authorities that a bare conductor of a potential not exceeding 1,000 volts alternating is not dangerous to persons standing on wet ground with dry shoes.

ELECTRIC EARTH CURRENTS VIEWED ASTRONOMICALLY.

By ARTHUR E. COTTERELL.

The existence of certain phenonema known as "earth currents" is familiar to many, but although the effect is at times very apparent to telegraphists all over the world, it may be stated that up to the present the cause is unknown, although some attempts have been made to collect such data as might enable a clear definition of the causes and laws to be set down.

Briefly stated, and quoting from Culley's Handbook of Telegraphy, it may be said: "Lines (telegraphic or telephonic) running *N.E. and S.W.* are most frequently affected. Lines running N.W. and S.E. are not often disturbed, and if affected, the currents are weak. It seems also that the direction in which the currents flow changes with the hour of the day, so that one line may be more strongly affected in the morning and another in the afternoon. The currents appear to enter at the earth plates (*i.e.*, ground connection). Their direction and strength are not determined by the actual course of the wires, but by that of a straight line drawn from one extremity, or earth plate, to the other.

The strength of the current varies *directly* with the length of the line.

Diurnal currents are *regular* but their direction and time of greatest and least strength differ with the locality.

A loop is an efficient preventative to such disturbances." (This eliminates connection with the earth.)

"When two wires are not available the circuit may be extended by connecting another to it which is so situated that a line connecting the termini of the joined lines lies out of the direction of the current at the time."

Recognising in common with other telephonists and telegraphists the existence of the above-mentioned phenomena, the author ventures to offer a few suggestions as to the probable cause of these very interesting and important effects.

It should be stated that the effects are almost exclusively confined to telegraphists rather than telephonists, inasmuch as it is only on those occasions of most exceptional severity which occur somewhere about every eleven years that any trouble is noticed in telephony and not always then. On these occasions false calls are sometimes received on electro-magnetic indicators or bells, though with the advent and practically almost universal adoption of magneto alternating current bells, the effect of the "direct" earth currents are not apparent.

In the case of telegraphy, however, false signals are of more frequent occurence.

At the outset one cannot help but feel that the problem is surrounded with much that is intricate and much that must at the present stage inevitably rest on conjecture. Nevertheless it is hoped that a basis may be laid down which will commend itself, not only as satisfactory, but as the only possible explanation. It will be seen shortly that there is need for the collection of a considerable amount of data which the author believes would readily be responded to by telegraphists and scientists all over the globe if some organisation was arranged whereby the information might be collected, co-related, and the results duly set forth in proper tabulated form. The astronomical departments of our own and other nations have shown in every respect all that zeal and peculiar ability for this class of work with such spendid results; and as it appears to the author that the relation to astronomy is of the most intimate order, he would venture to appeal with no little confidence to astronomers generally to give their valuable aid in a problem of such interest and importance.

No inconsiderable work has been done and important information compiled at various astronomical observatories with respect to magnetic inclination and declination, but the author cannot resist feeling that a closer study of "earth currents" would lead to a clearer definition and to results at present beyond conception.

However, to pass on more directly to the question at issue, it may be well to state that there is a very close intimacy between electricity and magnetism. In a word, electricity begets magnetism and magnetism begets electricity.

That the earth is a huge magnet is generally understood, and the compass needle is a sufficiently simple and clear demonstration of this fact.

It may be well to remind ourselves, however, that the magnetic poles are not identical in their locality with the geographical poles of this globe of ours.

The magnetic poles are moreover variable, sometimes being East and sometimes West of the Geographical Pole, at all events, in the case of the North Pole.

At the present time the magnetic N. Pole is relatively to Great Britain west of the geographical pole.

When Sir James Ross actually discovered the magnetic N. Pole, he found it to be situated in 97° West long. and 70° North lat. The South Magnetic Pole being situated 168° East long. and 76° South lat. Two very important facts now arise, viz.:—

(*a*) The Magnetic Meridian is eccentric to the geographical meridian.

(*b*) The N. and S. Magnetic Poles are not situated so as to represent an exact diameter of the globe, but are eccentrically situated, having their termini well within the Western Hemisphere.

It will now, perhaps, be as well to consider for a few minutes the various methods of producing electricity. They may be classed under three heads, viz.:

Frictional,
Voltaic,
Magnetic.

It might appear that friction due to the revolution of the earth plays an important part, did we not consider that there is every reason to believe that the atmosphere travels with the solid earth itself. Of course, there are numerous occasions arising of wind storms and air disturbances generally but, as we have seen, earth currents are of a *regular* character, and so we may dismiss this hypothesis from our minds. We must not, however, overlook the question of tides though it would be probable that their effect might be more or less coincident rather than the actual cause, if contemporaneous at all, as to which we may shortly see reason to the contrary.

Next in order, we have to consider voltaic action. There can be no doubt that this plays an important part in the matter of earth currents but of a class quite secondary and unimportant to those greater diurnal currents which we know *regularly change their strength and direction at different hours of the day*. These voltaic currents are not however without considerable interest, nor is their strength unimportant. They seem to arise from a variety of more or less similar causes, in all of which the earth plays the part of the electrolyte, *e.g.*, we have currents in lines whose earthed extremities lie in different kinds of subsoil; or where the earth plates are of dissimilar metals, or again earth plates of the same substance in similar or different subsoils have been known to produce currents where the plates have been in varying stages of oxidisation. It might be suggested that the varying temperatures as of, and between, day and night may effect the conditions of the subsoils, but such a supposition can hardly be tenable, inasmuch as such currents are noticeable even if slight in quite limited areas.

We now turn to the magnetic or electro-magnetic method of producing electricity, and here we find ourselves on the threshold of a theory which it would appear to be difficult if not impossible to resist. It may be well at this juncture to step aside for a moment to consider the fundamental principles which underlie the magnetic production of electricity, and *vice versâ*.

Suppose then we have a bar, or piece of iron or steel, and that we wrap round it a few turns of insulated wire. If now we join up the two ends of the coil of wire to a battery, the current from the battery will flow around or along the wire, and the iron or steel bar will have all the properties of a magnet.

On our breaking the connection with the battery the magnetic property will cease in the iron if it be softened in the first instance, but the magnetism will remain in hard iron or steel, unless the iron or steel be softened by heat afterwards, in which case it will be modified or destroyed altogether.

The polarity of the magnet will be determined by the direction of the current, and the strength more or less proportional.

On the other hand, if we suppose that the coil of wire is connected to the terminals of a suitable galvanometer, and

that a magnet is thrust into the midst of the coil, then we shall find that a momentary current of electricity is induced in the coil, and that another momentary current of opposite direction is produced by the withdrawal of the magnet. Or if instead of thrusting the magnet into the coil and withdrawing it, we cause it to approach to and recede from a piece of iron inside the coil, similar results ensue. Or again, similar results obtain if the magnet is placed in the coil and a piece of iron is brought near or taken away. The magnet may be of the permanent kind (*i.e.*, an ordinary steel magnet or a mass of loadstone), or it may be an electro-magnet. Familiar modifications of this principle are found in the dynamo, the magneto-generator of a telephone bell, &c. In all these cases coils of wire suitably arranged around soft-iron cores are caused to revolve in a magnetic field, and as a result of such coils cutting through their respective magnetic fields, by successively approaching and receding, currents of electricity are generated, which currents are periodically or alternately reversed in direction, and are called *alternating*. In some cases, by the aid of commutators, they are again periodically reversed in such a manner as to produce "direct" currents on the external circuit.

We must now keep before us the following absolute principles, viz.:—

1. "A magnet, rotating or moving in proximity to another magnet or a mass of any substance capable of magnetic properties will have its strength varied."

2. "A mass of iron or other substance capable of magnetic properties rotating or moving in proximity to a magnetic field will become more or less magnetic, and even vary in polarity."

3. "Heat applied to a magnet is capable of diminishing or destroying its magnetic properties."

4. "Any variation in the strength or the polarity of a magnetic core will induce currents of electricity in a surrounding coil of wire."

Having laid down these phenomena briefly, it would be well to consider now in what respect the earth may possibly in relation to some celestial body or bodies perform or be subject to analogous action.

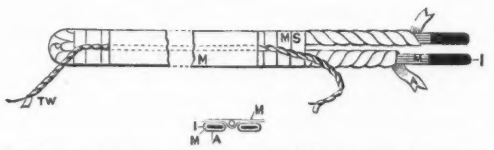
(*To be continued.*)

THE EFFECT OF TEMPERATURE ON THE MAGNETIC QUALITIES OF IRON.

The *Phil. Mag.* for September gives an account of the experiments of Dr. David K. Morris on the magnetic properties and electrical resistance of iron as dependent upon temperature. The paper was read before the Physical Society in May, and is printed in their Journal for the present month. It has long been known that the magnetic moment of a magnet varies with change of temperature, and many attempts have been made to establish a connection between the thermal and magnetic changes, upon the hypothesis of molecular rearrangement. At red heat, the *permeability* of iron fluctuates in a manner that suggested to Gore and Barrett an investigation of the magnetic properties at the temperature of recalescence. Further experiments by Kohlrausch, Hopkinson and Le Chatelier, relate to the change of *electrical resistance* of iron at the higher temperatures.

Dr. Morris has succeeded in obtaining simultaneous measurements of the electrical resistance and magnetic permeability of iron throughout cycles of temperature up to white heat, under various conditions of annealing. His apparatus consists of an annular core of iron strip, or wire, lapped throughout with asbestos as an insulator, so that the resistance of the strip, or wire, can be measured at any time. An insulated platinum wire is imbedded in the core, and its change of resistance gives the corresponding temperature. Further, the core is over-wound with a heating coil of insulated platinum wire, through which a current may be sent. The heat thus generated is under perfect control, and, by wrapping a thick layer of asbestos over all, loss by radiation is made very small, and the internal temperature remains very fairly uiform. The core is about an inch in diameter; a current of 4·6 amperes at 16 volts across the terminals of the iron wire is sufficient to maintain a temperature of 1,150° C.

To avoid oxidation of the iron, the ring magnet is enclosed in a glass vessel, from which the oxygen is absorbed by an auxiliary coil of bare iron wire heated to bright redness by an electric current. In some cases the vessel is partially exhausted by an air pump.

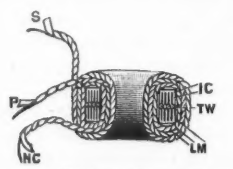


T W, Thermometer wire; M, Mica; M S, Mica slips; I, Iron; A, Asbestos.

Fig. 1.—Preliminary Stages, Half Full Size.

The chief difficulty lies in the insulation of the various wires at the high temperatures. When heated in a non-oxidising atmosphere, the luting contained in the asbestos carbonises, and brings the insulation down very low. This may be obviated by burning out all the hydrocarbons in one layer of the insulation, leaving, so to speak, nothing but the asbestos "ash," a white and very brittle covering, and then cautiously over-covering this with a layer of ordinary asbestos paper. Or mica previously heated in a Bunsen flame may be bent, or continuously broken, to follow the shape of the core, by pressing over a rounded edge. The heating of the mica is said to diminish the tendency to split; it burns off the raw cut edges.

Details of the construction of the core are given in figs. 1, 2 and 3. The iron strip, before winding, is slit up the

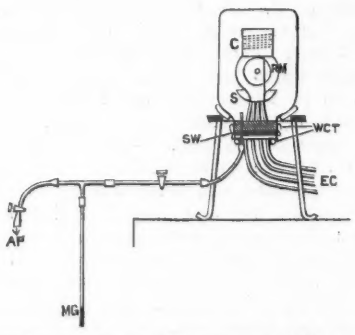


S, Secondary; P, Primary; H C, Heating coil; L M, Layers of mica insulation; T W, Thermometer wire; I C, Iron core.

Fig. 2.—Section of Completed Ring, Scale Half Full Size.

middle, so that it consists of two parallel conductors, each 4 mm. wide, joined at one end. The mean section is determined by the specific gravity method, and it is then insulated with mica and asbestos, as above described. The thermometer wire is laid in the space between the two parallel conductors, separated from them by cross-pieces of mica; the whole is then bent up into a ring.

The next step is to overwind the ring with three separate layers of platinum wire; these three serve respectively as the



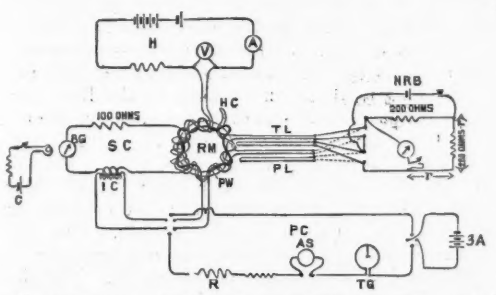
C, Coil for absorbing oxygen; R M, Ring magnet; S, Shield; S W, Sealing wax W C T, Water cooling tubes; E C, Electrical connections; A P, Air pump; M G, Mercury gauge.

Fig. 3.—Showing Ring in Glass Vessel.

magnetising coil or primary, the heating coil (wound non-inductively), and the secondary, all carefully insulated by asbestos or mica.

Fig. 4 shows the general arrangement of the electrical circuits. For standardising the ballistic galvanometer, an auxiliary ring magnet of known dimensions, having a non-

inductive core, is used. Its secondary, in series with the secondary of the specimen core, is in circuit with the galvanometer and a coil of 100 ohms. On reversing a known current in the primary of this auxiliary coil, the resulting throw is a measure of sensitiveness to change of induction in the secondary, whether in the core of the auxiliary or in the specimen core itself. Such standardising throws are observed before the readings at each temperature, and in this way direct compensation is made for alterations in the



H, Heating circuit; H C, Heating coil, non-inductively wound; N R B, Nett resistance bridge; T L, Terminals of iron specimen and leads; B M, Ring magnet; S C, Secondary circuit; B G, Ballistic galvanometer; C, Circuit for damping swings of ballistic galvanometer; I C, Induction coil of known dimensions for standardising; P W, Primary winding; P L, Platinum thermometer wire and leads; P C, Primary circuit; R, Resistance; A S, Ammeter for standarising; T G, Tangent galvanometer; 3 A, Three accumulators.

FIG. 4.—GENERAL PLAN OF CONNECTIONS.

resistance of the secondary circuit. The standardising throw, and the numerical data of the iron ring-magnet being known, it is possible to obtain from each ballistic observation the corresponding change of magnetic induction in the iron core. Correction has to be made for the induction that does not pass through the core. The tangent galvanometer and ammeter shown in fig. 4 measure the magnetising current. It is assumed that the magnetising force is uniform throughout that section of the ring occupied by the iron. This assumption is only approximately true.

Observations are taken, by the method of reversals, of the magnetic induction in the core for each of the eight values of the field, beginning with $H = 0{\cdot}078$ and $0{\cdot}153$ to get the permeability under very small forces, and ending with $H = 9{\cdot}20$. Next, the iron core is carried through a cycle of magnetisation between definite limits of magnetic field ($H = \pm 6{\cdot}83$), observations being taken by the "step-by-step" process—16 steps round the cycle. By repeating this several times the iron gets into a cyclic state. Then the iron is carried through a further cyclical magnetisation, this time between definite limits of induction ($B = \pm 4{,}550$ lines per cm.^{2}). Finally, the resistance of the iron is measured at the temperature of the particular experiment. The temperature has to be maintained constant with the utmost care, especially when working with the large magnetising currents, for they have a very perceptible thermal effect on the primary.

With regard to the results, it is interesting to note, first of all, the effect of annealing on the *maximum* permeability. In a given specimen, the process of annealing (at 1,050° C.) increases the *maximum* permeability at ordinary temperatures three-fold ($\mu = 1{,}355$ to $4{,}050$), and reduces the corresponding field to little more than half its former value ($3{\cdot}72$ to $2{\cdot}02$). Another set of experiments shows the difference between annealing at a red heat and at a low white heat. Iron annealed at 1,150° C. is rendered much more susceptible to weak magnetic fields than when annealed at 840° C. Annealed at 840°, the maximum permeability at ordinary temperatures is, in a particular case, about 4,000 in a field of $1{\cdot}84$ C.G.S. units. Annealed at 1,150° C., this rises to the remarkably high value 4,680, in the much smaller field $1{\cdot}48$. At temperatures immediately below the critical point this effect is even more striking. The critical point is about 770° C.

In the neighbourhood of 550° C. this same specimen exhibits a remarkable diminution of permeability; it is especially to be noticed when the magnetising force is about 1 C.G.S. unit. The effect is more pronounced after the annealing at 1,150° C. than after that at 840° C. The author points out that 550° C. is the temperature quoted by Tomlinson as that at which the internal friction of soft iron begins rapidly to increase; it is the temperature at which the "specific heat of electricity" for that material changes sign.

Under small magnetising forces ($H < 0{\cdot}5$) the permeability of iron rises at first slowly ($0{\cdot}2$ to $0{\cdot}3$ per cent. per degree) with increase of temperature. In the neighbourhood of 300° C. it rises quite rapidly. Between 400° C. and 550° C. it is nearly constant, and after that it rises with increasing rapidity to a very high value ($\mu = 12{,}660$ for $H = 0{\cdot}078$ is the highest *observed*). Finally, at the critical temperature, it sinks still more rapidly to a value quite insignificant.

As the field diminishes, the maximum of permeability increases, and the temperature at which the maximum occurs approaches the critical temperature, so that in very small fields the fall of permeability is sudden.

An examination of the (B, H) curves at various temperatures shows that as the temperature rises, the initial slope of the curve increases, and approaches more and more nearly to the maximum slope. And the critical temperature would occur at their coincidence, *i.e.*, when the (B, H) curve would start from the origin with its maximum slope, and the maximum permeability would occur in an infinitely small field.

Above the critical temperature (770° C.) the induction in iron is proportional to the magnetising force, indicating the same permeability for all forces, a result in accord with the results of M. Currie.

In the curves representing the cyclic magnetisation, the inclination towards the vertical axis increases as the temperature rises and approaches 550° C. With further rise of temperature the curves become more erect and angular. The area enclosed by each hysteresis loop represents, of course, the work done in ergs per c.cm. of the iron by the magnetic forces during one cycle. At the critical temperature hysteresis vanishes, the loops close up, and the work-factor $\frac{1}{4\pi}\int H \,.\, dB$ reduces to zero. Nor is there any evidence of the existence of hysteresis above the critical temperature; this is in agreement with the constant value of permeability in all fields at these temperatures. The effect of annealing upon the work-factor is exemplified by a particular case where the hysteresis at ordinary temperatures, for $B = \pm 4{,}550$, was originally 1,480 ergs per cubic centimetre per cycle. Prolonged annealing at 840° C. reduced this to about 800 ergs, whilst annealing at 1,150° brought it down to 612 ergs. Between 0° and 200° the diminution is 0·08 per cent. per degree, when the limits of induction are kept constant. The author does not agree with Kunz, who states that hysteresis is a linear function of temperature.

The latter part of the paper contains the results of the experiments on the *resistance* of iron at high temperatures. There is no abrupt change of resistance at or near the critical point, but the specific resistance may be reduced in some cases by annealing. Generally speaking, the resistance rises with increase of temperature, fairly uniformly, until a specific resistance of 100,000 C.G.S. units is reached. Here the maximum slope of the curve of change occurs, at a point only a few degrees below the critical temperature. The rate of increase of resistance then falls off rapidly, so that at 1,000° C. the temperature coefficient is about 0·0024 and the specific resistance 118,000.

THE THEORY OF THE INDUCTION COIL.

A MATHEMATICAL theory of the induction coil has been worked out* in a very much simplified form by Herr B. Walter, Hamburg, who has moreover verified the results obtained from his theory by experiments on an actual coil, and found that they are sufficiently exact for all practical purposes.

Walter emphasises the fact that a more exact theory of the induction coil is necessary, by showing that there are certain peculiarities in its behaviour which the ordinary theories fail to explain. For example, what is the true function of the condenser (first introduced by Fizeau)? It is generally assumed that the sole object of the condenser is to absorb

* *Wied. Ann.*, Vol. 62, p. 300.

the current flowing in the primary circuit when that circuit is broken, and thereby to prevent sparking at the break. That this is not the true function of the condenser, is shown by the fact which is no doubt known to makers of coils, that a condenser can be made too large.

Walter has shown how the length of spark is affected by the size of the condenser by experiments on a 30 cm coil made by Kohl, of Chemnitz. The break of this coil consists of a silver pencil reciprocated by a small electro-motor, so that it dips periodically into a layer of mercury covered with petroleum, which extinguishes the break spark very rapidily and effectively. In the experiments, the make and break were made by dipping the pencil by hand into the mercury, leaving it there for a few seconds, and then drawing it quickly out. The E.M.F and resistance in the primary circuit were so regulated, that the inductor with its normal condenser (of 0·22 microfarad capacity) supplied by the manufacturer, just produced the full spark length of 30 cm. This spark length was looked upon as just reached when 8 or 9 sparks were obtained out of 10 breaks. The spark was taken between a positive point and a negative disc of 15 cm. diameter. Condensers of varying capacity were now substituted for inductor's own condenser, and in every case the length of spark "just reached" was determined. The curve, fig. 1, shows the relation between the spark length in centimetres and the capacity of the condenser in microfarads. It is evident that the spark length of this coil

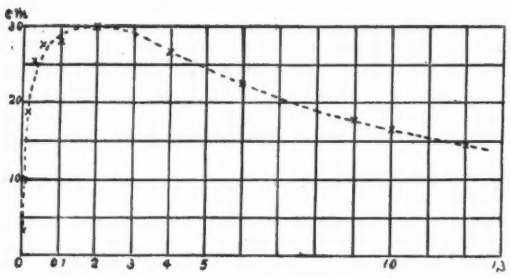
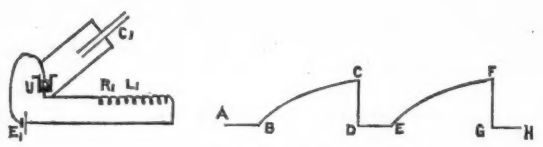


Fig. 1.

increases very rapidly as the capacity of the condenser increases from 0 to about 0·05 microfarads; from that to 0·2 microfarads it increases very slowly, and thereafter it falls off slowly and regularly as the capacity is still further increased.

Walter suspected that this remarkable bend in the spark-capacity curve would be explained by the existence of electric oscillations in the primary circuit, a theory which he succeeded in verifying both theoretically and experimentally.

Let fig. 2 represent diagrammatically the primary circuit of an induction coil, in which E_1 is the applied E.M.F., U the break, R_1, L_1, the primary coil (R_1 being its resistance, and L_1 its coefficient of self-induction), C_1, the condenser (C_1 represents also the capacity of the condenser in farads).



Figs. 2 and 3.

In determining the formulæ for the establishment of the current in the primary circuit when the break, U, is closed, it must be remembered that the effect of the secondary coil can be neglected, since no current passes in it till after the primary current has reached its maximum value. The equation, therefore, of the E.M.Fs. on closing the primary circuit is

$$R_1 i_1 = E_1 - L_1 \frac{d i}{d t} \qquad (1)$$

the integral of which is well known to be

$$i = \frac{E_1}{R_1}\left(1 - e^{-\frac{R_1}{L_1} t}\right). \qquad (2)$$

This equation gives the current, i_1 after the lapse of a time, t, from the closing of the circuit. This equation may be written in the form

$$t = \frac{L_1}{R_1}\left\{\log \frac{E_1}{R_1} - \log\left(\frac{E_1}{R_1} - i_1\right)\right\}, \qquad (3)$$

and from this it is easy to calculate how long the circuit must be closed in order that the current may reach a given value, i_1, all the constants, L_1, E_1 and R_1, having been previously determined.

Now, the striking distance of the secondary, will *cæteris paribus*, be proportional to the value of the current when the circuit is broken, and, moreover, in any given coil this current must not be allowed to exceed a certain limit in order to avoid damage to the insulation. In the Kohl inductor tested by Walter, this critical current was 5·8 amperes. The value of L_1 for this current was found to be 0·113, and the resistance of the primary circuit 0·56 ohm. If a 4-volt battery be connected up to the primary circuit, the time taken to reach the critical current, $J_1 = 5·8$ amperes, can be found by formula (3) to be 0·36 seconds. The mercury break was so arranged that during one revolution the circuit was open for $\frac{1}{4}$ of a revolution of the motor. The time to be occupied per revolution is, therefore, 0·36 + 0·12 = 0·48 seconds. Two revolutions per second ought, according to the formula, to give the maximum 30 cm. spark when a 4-volt battery is used to work the coil; and this result was exactly confirmed by experiment.

The maker of the coil had given instructions that a 12-volt battery was to be used to work the coil. Inserting this value of E_1 in the formula (3), we obtain the value of $t = 0·064$ second to give a critical current of 6 amperes. There is probably a slight increase in the resistance of the primary owing to the higher frequency, but even if the resistance is taken as 1 ohm instead of 0·56, the value of t is only increased to 0·075 second. This latter time corresponds to a speed of the motor, equal to 10 revolutions per second, which is the speed prescribed by the maker of the coil. By using a 24-volt battery and raising the speed of the motor to 20 revolutions per second, 20 full 30 cm. sparks were obtained from the apparatus.

The important point established by these investigations is, that for every voltage (within certain limits) used in working a coil, there is a certain speed of the break which will give the maximum spark length without injuring the coil. For example, a coil which gives its maximum spark length with 4 volts on the primary may be worked from a 100-volt circuit if the speed of the break is sufficiently increased. The D.P. generated in the secondary is the same in each case, the only difference is in the number of sparks per second.

Walter next proceeded to examine the nature of the current in the primary immediately after the circuit was broken. A mercury break driven by an electro-motor, as already described, was used in these experiments. It was found that petroleum, absolute alcohol, and turpentine oil, over the mercury, gave equally good effects, but when 80 per cent. spirit was used the spark length was 20 per cent. less.

When the primary circuit is broken at U, fig. 2, it will be seen that we have to do with a circuit containing a condenser, an electromotive force, E_1, and having self-induction. This condition of things, as is well known, gives rise to electrical oscillations. The electromotive force, E_1, may be neglected, since it only amounts to a few volts, and it will be shown later that the voltage due to the self-induction of the circuit is more than 1,000 volts. The back E.M.F. of the secondary coil $M\ (di_2/dt)$, since we are now dealing with what takes place in the primary circuit before the secondary spark takes place, may be also neglected. The neglect of this factor was also justified experimentally by showing that the variation of the primary current was the same when the secondary coil was entirely removed.

Taking into consideration what has been said above, what takes place in the primary circuit immediately after the break, may now be mathematically expressed by the following equation:

$$i_1 R_1 = -L_1 \frac{di_1}{dt} - \frac{\int i_1 \, dt}{C} \qquad (4)$$

where $L_1 \frac{d i_1}{d t}$ expresses the E.M.F. of the self-induction of the primary coil, and $\frac{\int i_1 \, d t}{C}$ that of the condenser.

Differentiating the above equation we get

$$L_1 \frac{d^2 i_1}{d t^2} + R_1 \frac{d i_1}{d t} + \frac{i_1}{C} = 0,$$

and the integral of this is

$$i_1 = A\, e^{-2\frac{R_1}{L_1} t} \sin\left[\frac{\sqrt{4 L_1 C_1 - R_1^2 C_1^2}}{2 L_1 C_1} t + B\right] \quad (5)$$

where A and B are two constants to be determined by the initial conditions. At the commencement of the break (when $t = 0$), $i_1 = J_1$ where J_1 is the maximum value of the primary current; further, at the same moment the charge of the condenser $\int i_1 \, d t = 0$.

From the first of these conditions the equation (5) gives

$$A \sin B = J_1 \quad (6)$$

and from the second, we get from equation (4)

$$J_1 R_1 + \left[L_1 \frac{d i_1}{d t}\right]_{t=0} = 0.$$

Differentiating equation (5) and making $t = 0$ we obtain

$$A \cos B = - \frac{C_1 R_1 J_1}{\sqrt{4 L_1 C_1 - R_1^2 C_1^2}} \quad (7)$$

and the equations (6) and (7) give us

$$A = - J_1 \sqrt{\frac{4 L_1 C_1}{4 L_1 C_1 - R_1^2 C_1^2}} \quad (8)$$

$$\tan B = - \frac{\sqrt{4 L_1 C_1 - R_1^2 C_1^2}}{R_1 C_1} \quad (9)$$

Equation (5) representing the variation of the current after the break, takes now the form

$$i_1 = - J_1 \sqrt{\frac{4 L_1 C_1}{4 L_1 C_1 - R_1^2 C_1^2}}\, e^{-\frac{R_1}{2 L_1} t} \sin\left[\frac{\sqrt{4 L_1 C_1 - R_1^2 C_1^2}}{2 L_1 C_1} t - \tan^{-1} \frac{\sqrt{4 L_1 C_1 - R_1^2 C_1^2}}{R_1 C_1}\right] \quad (10)$$

In the present case, however, this equation can be considerably simplified. Since C_1 is very small compared with the other quantities (in the Kohl inductor, for instance, $C_1 = 0{\cdot}22\ 10^{-6}$ farad, but $R_1 = 0{\cdot}56$ ohm and $L_1 = 0{\cdot}113$ henry) the expressions in the equation containing C_1^2 can be rejected. Equation (10) therefore becomes

$$i_1 = - J_1\, e^{-\frac{R_1}{2 L_1} t} \sin\left[\frac{t}{\sqrt{L_1 C_1}} - \tan^{-1} \frac{2}{R_1} \sqrt{\frac{L_1}{C_1}}\right]$$

For the same reason, $\tan^{-1} \frac{2}{R_1} \sqrt{\frac{L_1}{C_1}}$ is always approximately equal to $\frac{\pi}{2}$: for example, in the case of the Kohl inductor under consideration, the value is 89° 58·6′. Therefore, the equation is still further simplified to

$$i_1 = J_1\, e^{-\frac{R}{2 L_1} t} \cos \frac{t}{\sqrt{L_1 C_1}}. \quad (11)$$

This equation shows that regular oscillations in the current arise when the break takes place in the primary circuit; the periodic time, T, of these oscillations is determined by the equation,

$$T = 2 \pi \sqrt{L_1 C_1}. \quad (12)$$

By introducing this expression, equation (11) becomes

$$i_1 = J_1\, e^{-\frac{R}{2 L_1} t} \cos 2 \pi \frac{t}{T}. \quad (13)$$

The factor, $e^{-(R_1 / 2 L_1) t}$, shows that we have here to do with damped oscillations, which, of course, must be the case when electric energy is being constantly converted into heat in accordance with Joule's law. There are other losses of energy, such as those which arise from the leakage represented by the spark at the break, and those due to hysteresis in the iron core. These are far greater than the loss due to heating of the wire, but they have not been taken into account in the above equations. When the oscillations are afterwards drawn experimentally, the amount of these losses will be evident from a comparison of the theoretical curves with the experimental curves. The periodic time, T, of the oscillations in the primary circuit according to equation (12), depends only on the quantities L_1 and C_1, and, therefore, ought not to be influenced either by the resistance of the primary circuit or by the presence of a break spark. This conclusion will be afterwards confirmed by experiment.

Walter now proceeds to give experimental evidence of the oscillations indicated by his theory. For this purpose he uses an apparatus devised by Braun.* In Braun's apparatus, a thin pencil of cathode rays is obtained by passing the rays through a narrow slit in a diaphragm placed across the vacuum tube. The pencil of rays impinges on a transparent phosphorescent screen where it produces a very small bright spot. If placed in a magnetic field, the pencil will be deflected at right angles to the lines of force, and the bright spot on the screen, when examined by a rotating mirror, will show the smallest variations of the magnetic field.

Before using this apparatus to determine the course of the break-current, Walter decided to ascertain whether his theoretical conclusions as to the growth of the make-current were verified by experiment. He found that the curve seen in the rotating mirror was a logarithmic curve exactly as indicated by the formulæ (2) and (3). In fig. 3 are shown two successive curves, B C, and E F, representing the rise of the make-current. The curves of the break-current, C D, and E F, are drawn here approximately as straight lines, but their true form will be shown by a more delicate method.

In these experiments the Braun tube was fixed up with plane of its diaphragm coinciding with the prolongation of the axis of the primary coil, *i.e.*, with the cathode pencil at right angles to the magnetic lines of force proceeding from the core of the inductor.

(*To be continued.*)

REVIEWS.

First Principles of Electricity and Magnetism. By C. H. W. Biggs. Published by Biggs & Co., London. Price 3s. 6d.

This book is intended for beginners in practical work; it is meant in some degree to follow the syllabus of the City and Guilds' Institute. The first chapter treats of the relations between mass, weight and force; work and power; watts and kilowatts. The second introduces electromotive force, current, and resistance. The third and subsequent chapters deal with electric bells, magnets, measuring instruments, dynamos, induction phenomena, transformers, and electric lamps. In short, it is a compilation, with pretensions to being a text-book of electricity and magnetism.

We regret that only small praise can be afforded to this volume. Its phraseology is too often loose; its theories are too often muddled, and on too many points the student is left in a condition worse than ignorance. After alluding to velocity as "motion through a space of time," and to power as "the transference of energy through a space of time," some general ideas are given of electrical quantities. Speaking of electrical resistance, the author says: "We might take for a unit the wire that has capacity for 1 ampere under a pressure of 1 volt. This wire of unit capacity would have a certain length with a given sectional area. If two wires were used in parallel of this length and sectional area, the capacity would be doubled, and every conductor might thus be looked upon as composed of parallel wires of given capacity." The introduction of the term "capacity" in this connection is a false step, and cannot fail to bring confusion to the mind of students.

Statical electricity is ignored from beginning to end of the book, so that when it becomes necessary to speak of "charge," we get some very curious paragraphs. A figure is given of two condenser plates, A and B, connected respectively to the poles of a battery; the author proceeds as follows: "Any electric circuit of the kind just described, where the ends of the conductors, or the ends of the conductors enlarged, are connected only through air, or some other non-conducting material in the place of air, is called an *inductive* circuit. In an inductive circuit the phenomenon called *charge* takes the place of the phenomenon called current in the conductive circuit, and is subject to the same law, or say law similar to that of Ohm. For convenience of

* *Wied. Ann.*, Vol. 60, p. 552.

formulæ, let us use the term 'accumulation' instead of charge, and signify accumulation by the symbol, A. In the conductive circuit

Current × resistance = electrical pressure, *i.e.*, C × R = E.

In the inductive circuit,

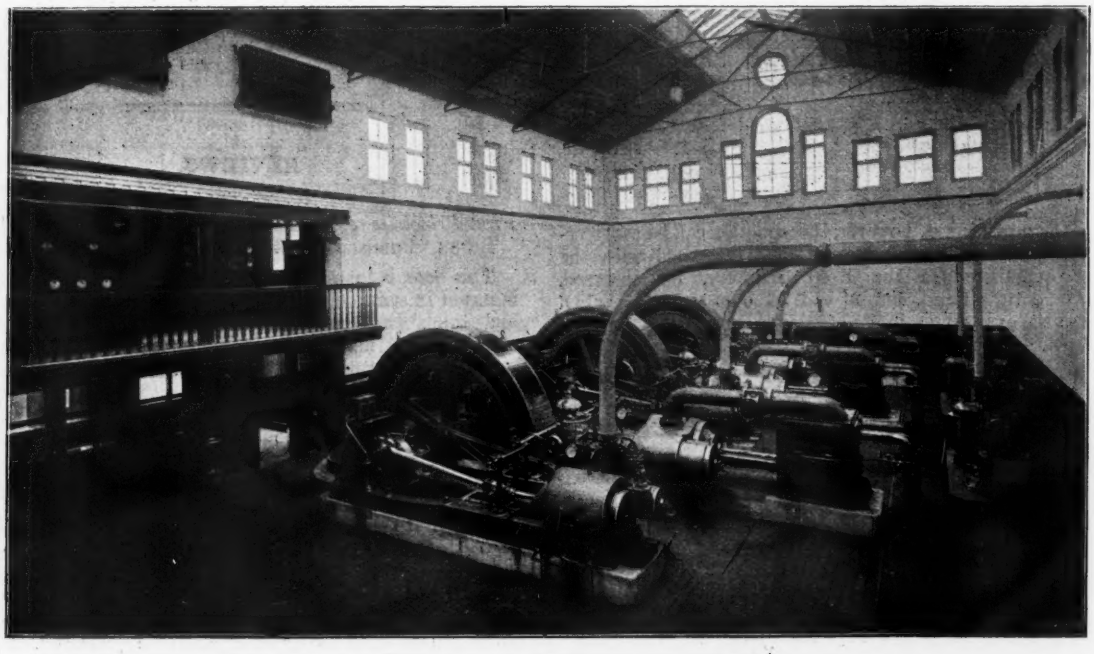
Accumulation × resistance = electrical pressure, *i.e.*, A × R = E.

Instruments fashioned to measure A instead of C, and by this means to obtain the value of E, are called electrostatic instruments, or open coil instruments. Before describing any of these instruments it should be mentioned that in the inductive circuit, as in the conductive, the point at higher potential or pressure is called positive, or indicated by the sign (+), to the point or lower potential, which is termed negative, or indicated by the sign (−)." The misconceptions contained in that single paragraph are sufficient of themselves to condemn the book. Neglect of statical phenomena—the electroscope, the proof-plane, and the glass rod—leads our author into worse and worse confusion. Here is his definition of a condenser: "A condenser is a piece of apparatus wherewith to obtain large conducting surfaces acted on in the inductive circuit, with small dielectric resistance and large accumulation, or greater capacity." The whole sentence is irrational enough, but to describe a condenser as an apparatus wherewith to obtain "small dielectric resistance," is a gross and culpable misuse of terms. In the very next line we are told that "the formula $A = \frac{E}{R}$ is as comprehensive for the inductive circuit as $C = \frac{E}{R}$ is for the conductive." Some, at least of this muddle might easily have been saved by explaining the meaning of R in each case, or by using different letters, say, Q = F V.

The algebraic proofs, even of the simplest theorems, are feeble and roundabout. For instance, in deducing a formula for the joint resistance of parallel wires, a factor, *r*, is introduced with no apparent object; it is immediately afterwards rejected. The Wheatstone's bridge proof is too weak for notice.

Of galvanometer shunts the author says:—"We use a multiplier, called the multiplying power of the shunt, and this is merely the sum of the ratios of the resistance of the galvanometer and shunt." How is the beginner to derive $\frac{G+S}{S}$ from such an erroneous statement? But ratios, we may remark, are never very clear to the mind of Mr. Biggs; he defines π as "the ratio of the diameter to the circumference of a circle," instead of the reciprocal of that quantity, and he is lost in wonder at $\frac{4\pi}{10}$.

This expression $\frac{4\pi}{10}$ crops up among his "Notions about Magnetic Lines of Force." "I am not at all certain," he says, "of the correctness of the theory—or lack of theory—that brings about this formula (*sic*). To me it is somewhat of an absurdity. . . . . This means that 4π or $4 \times 3{\cdot}1416$, or $12{\cdot}5664$ lines of force proceed from the unit pole. How you can conceive of a fraction of a line proceeding from anything is beyond my grasp. . . . . You must not imagine, however, that wrong results are obtained by using $\frac{4\pi}{10}$ or any other similarly ridiculous formula (*sic*)." We sympathise with Mr. Biggs in this difficulty; yet we are inclined to believe that the error is not due to those theorists who adopted the convention, but to providence—who designed small spheres. Clearly, the square of the radius ought to have been arranged as some simple ratio to the spherical surface, say, 3 or 4, or reciprocals of those numbers. Providence, by a similar absurdity, has designed the circle so that its diameter is a ridiculous submultiple of its perimeter. Some consolation and truth may be derived from what Mr. Biggs says, *i.e.*, "any convention may be utterly ridiculous, viewed in the abstract; but if it is universally agreed to, why everybody knows what is meant and what is wanted."



Reading.—View of the Generating Plant.

Confusion is even worse confounded when the distinction between ammeters and voltmeters is dealt with. In trying to state this problem, the equation $C = \frac{E}{R}$ is written down just nine times, and all the force of a water analogy is brought to bear upon it, but to little purpose. The muddle might easily have been avoided by defining the circuits, and by stating whether C is the current in the main circuit or the current through the instruments, and whether R is the resistance of part or all of the circuit, or the resistance of the instrument.

Coming to the consideration of the mechanical equivalent of heat, the author laments the different values of J, as given by different authorities. With justice he says: "We ought to have some pity for the young student." Indeed we ought, and we therefore advise the youthful reader to refer at first

hand to the work of Mr. E. H. Griffiths on this matter. Mr. Biggs finishes this discussion by a quibble over one of Prof. Ayrton's arithmetical results. He observes that "The laxity of authors in choosing approximations should be regulated, and upon no account should a student lose marks because he uses another constant than that favoured by an examiner." Examiners generally see to this by giving all necessary constants to the examinees.

And that same pity for the youthful student leads us to warn him against yet another stumbling-block. The author gives a diagram of looped wires, and tells us this is "electrically the same as if the conductor strands were twisted to form one single conductor." This might be interpreted to mean that a strand is of equal resistance to its component wires when looped. We have some pity for the young student.

READING ELECTRICITY SUPPLY WORKS.

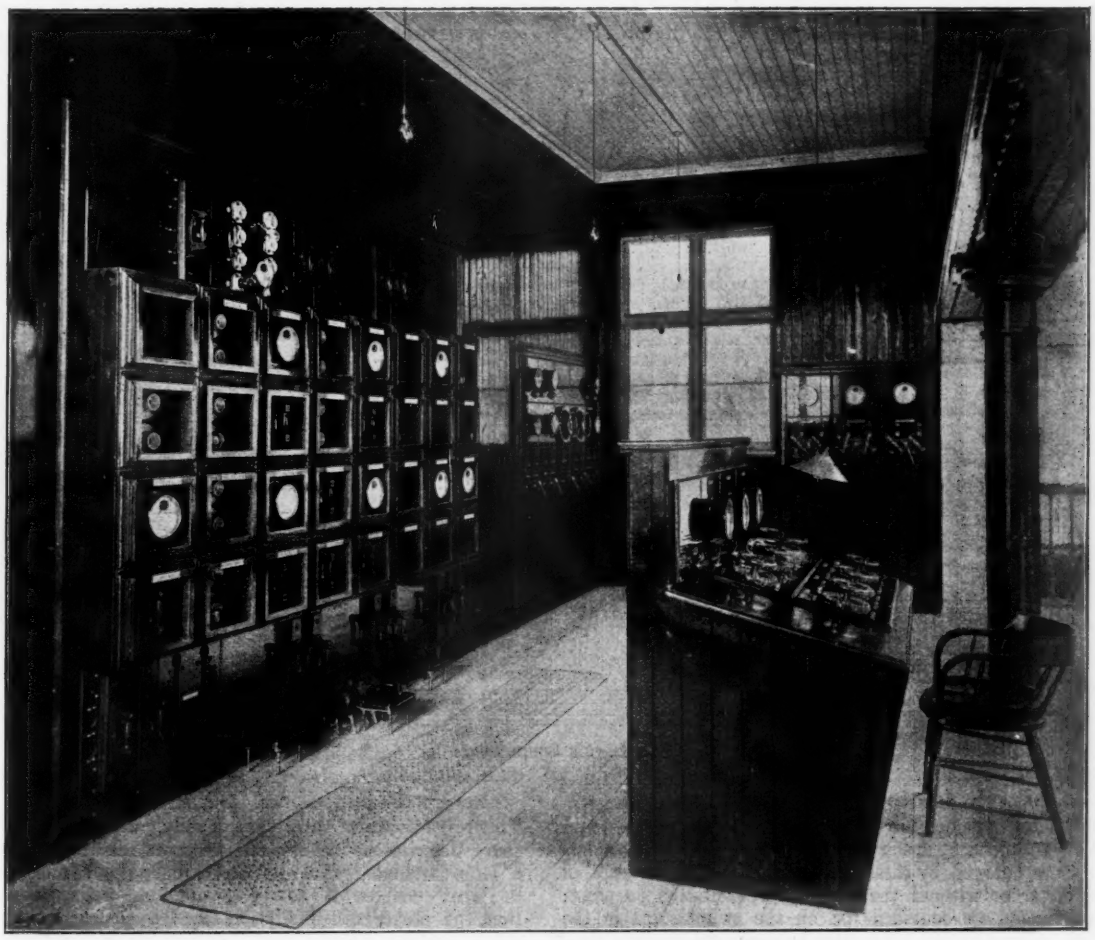
The enormous strides made within the past eight or ten years in the generation and distribution of electricity for lighting purposes are apt to be forgotten and the recollection of their importance dimmed by the continued progress of to-day. A recent visit to the new station of the Reading Electric Company, and the recollection of a previous visit years ago to the old station in the centre of the town, brought this fact forcibly to the writer's mind.

In March, 1889, thousands of people congregated in the main streets of Reading to witness the switching on of the current to the public arc lamps. The original plant was put down by Messrs. Laing, Wharton & Down, under the superintendence of Mr. F. F. Yeatman, the present engineer and manager to the company.

It was an arc lamp plant only, and consisted of two engines, each indicating 25 H.P. when running at a speed of 280 revolutions per minute, and supplied with steam at 110 lbs. pressure. The dynamos were of the Thomson-Houston "H" type, each running at a speed of 950 revolutions per minute, and capable of supplying 18 arc lamps of 1,200 candle-power each on a circuit comprising the main streets of the town. This plant had not been in use a year when the demand for more light, both arc and incandescent, rendered it necessary to considerably increase the plant. The above machinery was taken out, and in its place three 30-light T.H. alternators were put down, also two 25-kilowatt alternators of the same make for incandescent lighting. Another Babcock and Wilcox, and a locomotive boiler were also added. The switch gear was of the T.H. standard pattern of that period throughout.

The arc light machines worked at 1,500 volts, while the incandescent machines generated their current at 2,000 volts. The current was conveyed by means of overhead mains to individual transformers in each consumers' premises, when it was converted to a low pressure. The arc lighting, both public and private, was by contract for certain hours' running, the carboning and keeping in repairs and controlling the switching on and off being done by the company. A great many of the T.H. meters, which were in use at this time, are still at work, and giving satisfaction, although the Westinghouse and Chamberlain and Hookham are now principally used.

It is perhaps unique in the history of electric lighting of a town to find in charge to-day the engineer who has been associated with the growth of the industry from its birth, and who has successfully nursed it through its babyhood,



Reading.—View of the Switchboard.

boyhood, and has started it fairly on its road to robust manhood, and well able to take care of itself before bidding it farewell. Such is the case with Mr. Yeatman, and to listen to his interesting narrative of the successive stages gives one interested in the progress of electric lighting infinite pleasure.

A vast amount of experience has been gained by these successive stages, and one is struck on entering the present works with the foresight in the selection of the units of plant, and their arrangements with reference to future extensions.

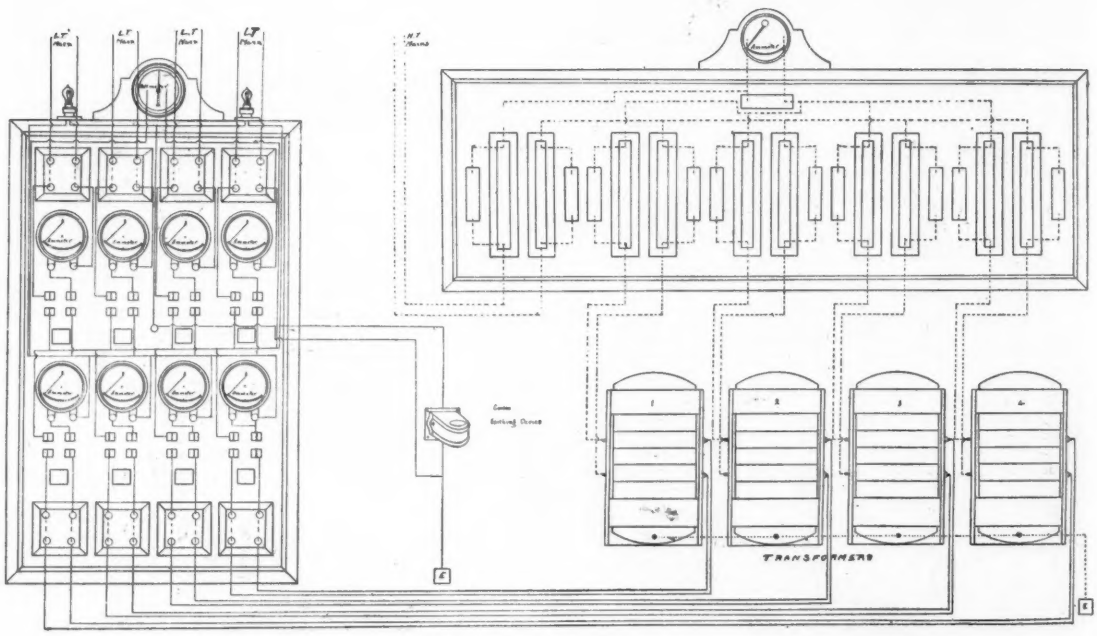
The site measures 450 feet × 300 feet, with a frontage of 300 feet to the river Thames. The whole is surrounded by a high brick wall, the offices being at the Vastern Road entrance, which is the end most remote from the river and works.

The present plant is a high tension alternating current transformer system. The units are three in number; the engines are of the horizontal slow speed type, manufactured by Messrs. Fowler & Co., of Leeds, as were also the alternators, which are of the Hall type, and are coupled direct to the engines. They are of 125 kilowatt capacity each. The field magnets form the fly-wheels, and these are surrounded by laminated charcoal iron rim armatures. There are two exciters, the engines of which manufactured by Messrs. W. H. Allen & Co., Bedford. These run at a speed of 250 revo'utions per minute, the engines being capable of developing 23 H.P. when supplied with steam at 125 lbs. pressure.

of connections at the back, covered with inflammable insulation, such as porcelain or glass. A temporary wooden partition in the engine house just now shuts out the building operations going on in connection with the erection of a fourth unit of plant. This one, which is of the same type and manufacture as those already installed, will be of 250 kilowatt capacity. A large pit is dug out and supplied with strong concrete bottom and sides, whereby the lower half of the armature can be lowered for examination, cleaning and repairs. Access is gained to this pit by means of a trap door in the floor, placed directly in front of the engine. The condenser will differ from those at present in use as regards position, for it will be sunk in the floor at the rear of the engine, the motion to the pump being by a bell-crank lever. Engine room floor space is thus economised.

In the boiler house the foundations are complete, and everything ready for the reception of a new boiler, which is being built by Messrs. H. & T. Danks, of Netherton. It will be of the same dimensions and type as its fellows, namely, 30 feet long by 8 feet diameter, Lancashire type.

The fittings on the fronts of all the boilers are kept clear, so that at any time mechanical stokers can be fitted to them. The gauge glasses are very high up, and the water gauges are placed one on each side. Coal is brought in from the coal shed adjoining the boiler house in tilting bogies, but instead of the coal being shot out on the floor in front of the boilers, each has a bogie placed in front of it, from which coal is served to the furnaces. Cleanliness is thus obtained.



Sub-Station Connections.

The exciter dynamos are coupled direct to the engines, and are of 10 kilowatt capacity each. A set of E.P.S. accumulators are charged by these exciters, and are run in parallel with either or without the exciter for excitation purposes; arrangements are provided for on the switchboard in the switch gallery, whereby the two exciters and accumulators can be put in parallel or used separately to excite the alternators.

The position of the switch gallery is well chosen, is easy of access, and commands a view of the whole of the machinery. The switch gear is of the Lowery-Hall type. The bases of the fuses are slate in all cases. The facilities for enabling the attendant to put alternators in parallel with precision and alacrity leave nothing to be desired. Mr. Yeatman is high in his praise of the performance of his alternators when running in parallel, and the ease whereby they can be synchronised and put into parallel.

We would, however, like to see the total abolishment of *wood work* in main switchboards as well as the employment

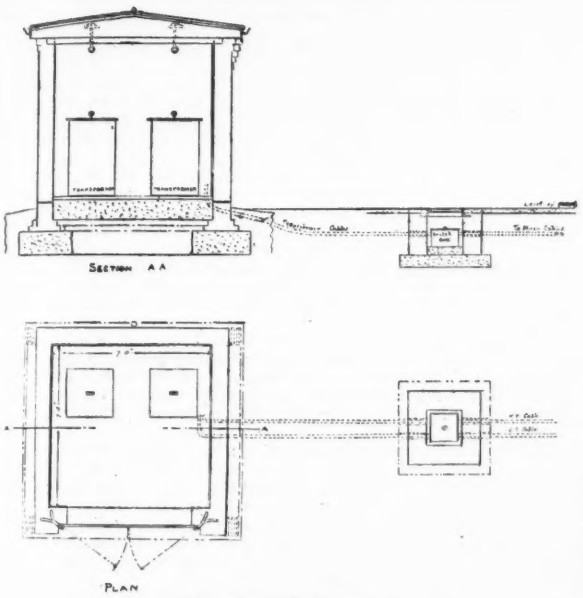
These conveyances are very handy, and are worth a short description. The coal receptacle is the shape of a large triangle, with its base uppermost; an axle at its apex enables it to be swung on its carriage, so that the stoker can easily obtain the coal. Each bogie carries one ton, and the whole apparatus is so designed and constructed, that no inconvenience is experienced in wheeling it from the store into the boiler house. A partial division divides the triangular holder into practically two compartments, the object being to prevent the coal falling out when the holder is tipped. This division does not in any way interfere with getting at the coal.

At the back of the coal shed is found the water tanks for condensing and boiler feed purposes, the supply being obtained from a well sunk on the premises, close to the river's edge. A Green's economiser, placed at the base of the smoke stack, utilises the heat from the waste gases from the furnaces for heating the feed water to the boilers.

The whole of the overhead mains have been taken down

and replaced by Callender and Fowler-Waring concentric armoured mains, laid directly in the ground. In the outlying districts, where, by the way, considerable recent extensions have been made, transformers are placed at convenient spots in the line of mains. These transformer chambers differ materially from the usual class, by being built of brick, and placed above ground. These chambers are substantially built of 9-inch brickwork, tiled or slated, according to fancy, and the architectural design can be made to suit the surrounding buildings. The switching arrangements for cutting transformers out of circuit on both high and low tension, are enclosed in a damp-proof box buried in the pavement a few feet away from the chamber. Diagrams of sub-station switchboards are shown on page 534; the low tension board being on the left of the illustration, and the high tension on the right.

In provincial towns no great difficulty is experienced in renting or purchasing a small plot of land, either in the corner of a garden or yard adjoining the chamber; this system of transformer is much to be preferred to those veritable death traps so universal, and in which from time to time lives are lost,



Transformer Station.

the public never learning of the narrow escapes from death or permanent injury to which the attendants are exposed.

It is obvious that ease of ingress and egress facilitates the work of inspection, cleaning, maintenance and repairs, and the value of disconnecting the sub-station at a point *outside* of the same is great. The accumulation of gas is easily prevented, or in fact cannot collect, for adequate means for ventilating are provided.

It is perhaps to be regretted that Mr. Yeatman, who has handed in his resignation, and who severs his connection at the end of October, should not see the completion of the important addition to his plant and mains; but we feel sure that his successor will have no difficulty in completing the work, and in following up the lines he has so ably laid down, and we would wish to say in conclusion, and we believe it is the opinion of many others, that for cleanliness, perfection of detail in working, and attention to all those details which go to make up a successful electric supply station. Reading will scarcely find an equal. In Mr. Yeatman's new sphere of life, whatever it may be, we extend our best wishes for his welfare and success.

Mr. Arnot's Resignation.—We understand that the Electrical Committee of the Glasgow Corporation has accepted Mr. Arnot's resignation, and the Corporation is now advertising for an electrical engineer to take charge of and give advice on all electrical matters under the Corporation, including both electric lighting and motive power. See our "Official Notices" for particulars.

STEAM ENGINES FOR ELECTRIC LIGHTING PURPOSES.*

By JOHN DAVIDSON.

(*Concluded from page* 521.)

Again, the expansive governor is more in favour of close governing than the throttle on account of its immediate effect on the valve of the engine, whereas in the throttle governor the throttle valve has no effect upon the steam already in the steam chest, which is often sufficient to make an engine run away. This advantage is still greater in the case of compound engines where the expansion governor acts both on the high and low pressure cylinders together, and so has the engine under control in a very short space of time, while if the throttle did not act quickly on the high pressure cylinder it could not have any effect upon the steam already in the receiver.

There is also a variation in speed which occurs during each revolution which cannot be effected by the governor, caused by the unequal turning moment of the engine, this of course can be lessened by the fly-wheel. These engines must therefore be fitted with good fly-wheel power to reduce this fluctuation to a very small amount. In double engines and compound engines with cranks at right angles

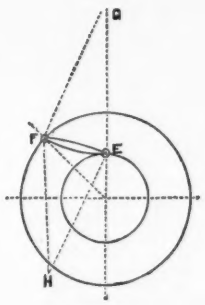


Fig. 5.

and much more in three cylinder engines with cranks at 120°, the fluctuation per revolution of the turning moment is very much less than in a single crank engine, and is therefore not so much dependent on the fly-wheel for help in this direction.

Concerning the mechanical construction of the two types of governors, I think the one can be made to respond as quickly to a sudden change of load as the other if properly designed, but suppose we take this for granted, the expansive governor will act directly on the cylinder valve, while the throttle, although it does act as soon, will only effect the steam some distance away from the valve. Therefore, its effect cannot be felt by the engine as soon.

Judging from what I have just considered, I think it would be safe to say that the expansive governor is the most suitable for this class of engine with very varying loads, and I will now mention a few points in the construction of this type of governor.

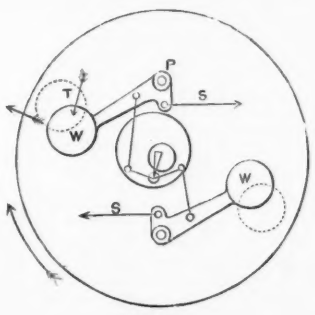


Fig. 6.

Up to the present, in speaking of the variable expansion governor, I have not stated any particular form it should take, but as this paper deals only with high speed engines, Corliss, and other trip gears of any description, cannot be included, but governors acting on the eccentric driving the valve in such a manner as to alter the cut-off automatically to suit the load. This, then, is what is generally known as the automatic shaft governor.

Before going any further, I will just point out the way the governor must act on the eccentric to vary the cut-off. First, the governor must allow the eccentric to give the latest cut-off that will be required to give the maximum load the engine has to deal with.

* Paper read before the Salford Science Students' Association at the Royal Technical Institute, Salford.

Second. It must be able to reduce the cut-off to a minimum, or, at any rate, to allow only sufficient steam to pass the valve to turn the engine at its ordinary speed without any load. To do this the governor must vary the throw of the eccentric together with the angle of advance, see fig. 5. There are many ways of shifting the eccentric to give this result, among which are:—Sliding the eccentric on slides by swivelling it on a pivot or by revolving the eccentric on another or in another, but it is not within the scope of this paper to consider all these methods in detail.

The number of shaft governors now in use could hardly be totalled. They are all designed to fulfil one purpose, yet in very different lines. Some make use of the centrifugal force of weights controlled by springs only, and in some both centrifugal and tangential inertia are brought into action to effect a change in the governors, but in all of any note, centrifugal force is the principal and essential governing force. The next question is how to apply these forces so that they may act in the best possible manner to change the position of the eccentric, so as to alter the cut-off to suit the load.

In a great many governors of this type, the governing mechanism

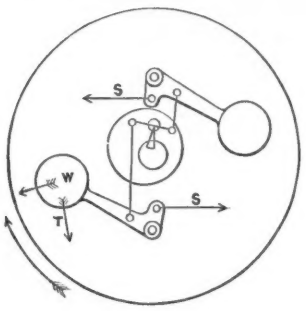


Fig. 7.

consists of two weights placed opposite each other, and pivoted some distance away from their centres of gravity. Their position, according to the speed of the engine, being controlled by springs. A governor with weights arranged in this way is shown in the diagram No. 6, which may be taken as a typical one of this kind.

The weights, W, tend to fly out in the direction shown by the arrow, C, due to centrifugal force, but this force is balanced by the tension of the springs, S. As the centrifugal force of the weight increases, due to its greater radius when it moves to an out position or further away from the centre of rotation, the tension of the spring also increases to balance it, but it is not advisable to design the springs to balance the centrifugal force at the same speed for all positions of the weight, as then there is nothing to settle the position of the weights, or the governor will be very unstable, the slightest variation in speed causing the weights to move from in to out position, and to make the governor hunt. Therefore, for stability in a governor, it is desirable to have a slight variation in speed between the in and out positions, or between full and no load of the engine. This variation, of course, can be made very small, even to 1 per cent. with some governors, varying with the type. Suppose, now, that some of the load be thrown off the engine, there will be a momentary increase of speed, and this will increase the centrifugal force of

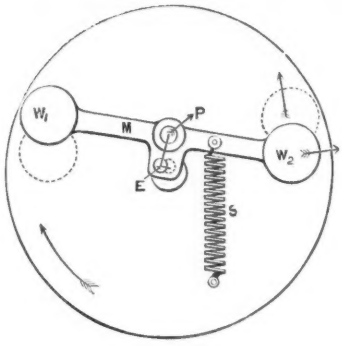


Fig. 8.

the weights, causing them to take up another position, as shown by the dotted circles, this motion being transmitted to the eccentric by means of the links causing it to cut off earlier and prevent further increase in speed. When this change in the rate of rotation takes place, another force other than centrifugal force comes into play as will be seen by referring to the diagram.

The weights, W, being freely pivoted at P, when a sudden change in the rate of rotation takes place, will tend by their own inertia to move tangentially or in the direction shown by the arrows, T. This force, which instantly acts with the change in rate of rotation is, you will see, in opposition to the centrifugal force, and will therefore stop prompt action of the govenor, but as this force can act momentarily only, or during the change in rate of rotation, it will simply make the governor a bit sluggish in responding to the alteration of the load.

If the weight were pivoted as shown in the Diagram No. 7 when a change in the rate of rotation takes place in this case, the tangential force of the weights will act with the centrifugal force, and make the govenor much quicker in acting and more sensitive to a slight change, thus lessening the momentary variation in speed.

You will also notice that in the last arrangement of the governor, the path traversed by the eccentric is very different from the first, see fig. No. 5, being struck from a centre, G, on the same side of the shaft as the centre of the eccentric. The centre of the eccentric is shown at the minimum travel at E, and the maximum at F. This path reduces the lead of the valve more rapidly, and consequently at early cut offs the valve has a small lead, and also a proportionately small port opening at light loads, which throttles the steam. Some engineers on this account prefer the other path, with a radius struck from a point, H, as they say an advantage is gained by getting a better port opening with more lead at the light loads, but I must say that I do not think they get all the advantage they claim, for at light loads the throttle governor is undoubtedly the best for economy, so anything that will tend to combine the throttle with the expansive governor at early cut offs has rather the advantage.

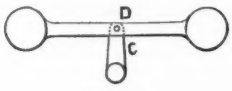


Fig. 9.

This path does allow of sufficient lead at light loads to prevent a fall in pressure at the commencement of the stroke, and at heavier loads the lead and port opening can be arranged to be practically the the same as in the other governor.

As you will see, this governor consists of two weights, two springs, two links, and an eccentric mounted on a pivot, and many governors have more parts than this one which leads to great complication and expense, to say nothing of the liability to get out of order and the enormous amount of friction caused by so many joints, which is very serious, and takes away all the sensitiveness, as a considerable variation has to take place before the forces of the governor are sufficient to overcome it. Therefore the simpler a governor can be made, and the fewer the joints, the better.

The simplest governor in the market that I know of, consists only of one piece of metal in which all the necessary governing forces are advantageously arranged to act in harmony. This governor is shown on Diagram No. 8, and is known as Begtrup's Patent Governor, the sole licencees for this country being Messrs. Browett, Lindley & Co., Limited.

It consists of one mass, M, pivoted at P in the form of a bar, the bulk of the mass being concentrated at the ends W_1 W_2, and the centre of gravity of the whole without the acting weight being at P, to this mass is attached the eccentric or pin to drive the valve at E, and the spring to control the centrifugal force of the acting weight, W_2, at S. I must mention here that the portion of the mass at W_2 is made greater than the similar portion at W_1 to act as the centrally acting weight of the governor.

A new force is developed in this form of governor which I will first explain. Suppose you had a bar with a bob weight at either end freely pivoted at D on the end of a crank arm, C, see diagram No. 9. Now let this crank arm, C, be suddendy moved through, say, about one quarter of a revolution to position shown by fig. No. 10. The bar and bob weights will not remain at right angles to the crank arm as if rigidly fixed to it, but will remain horizontal unless some other force be applied to it, as shown by arrows. Returning to the diagram of the governor you will see that the mass, M, has to make a complete revolution round its centre, P, during each revolution of the engine. When running at a uniform speed the force necessary to turn the mass in this way is given by the spring, but if a sudden increase or decrease in the rate of rotation takes place, this state of

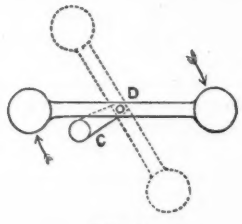


Fig. 10.

equilibrium becomes out of balance, as the mass being freely pivoted at P tends to go on at the uniform rate only and so lags behind or gets ahead a little, cutting off earlier or later to bring the engine to the normal speed. This force, therefore, due to angular inertia acts as a governing force. The main governing force, viz, the centrifugal force of the acting weight, W, is balanced by the tension of the spring, S, and on further examination you will also see that the momentary tangential force of the acting weight tends to help the centrifugal force, and it has been shown that the force due to angular inertia acts in this direction, so in this very simple mass of metal, is contained all that is necessary when properly pro-

portioned to form a sensitive, certain, and almost frictionless governor most suited for engines with very varying loads, requiring fine regulation in speed as for electric lighting purposes, and more so for electric traction.

Economy.

As I said at the commencement of this paper, the speed of rotation has been greatly increased, but on account of the stroke being shortened the piston speed remains about the same in high speed as in slow speed engines. This means that the ports in the high speed engines must be about equal in area to those of the slow speed, although the volume of the cylinder has been decreased in proportion to the stroke. This points to excessive clearance spaces in the cylinder, a most serious loss as you all know, but in short stroke engines the ports are shorter, and by keeping them as straight as possible and as small as is advisable, but not too small and cause port friction to reduce the pressure, this is the only way out of the difficulty.

Again, in high speed engines, the steam is admitted and exhausted from the cylinder many times oftener per unit of time than in a slow speed engine. This means that the cylinder is heated and cooled oftener, but as the time of exposure to the cylinder walls, &c., is thus lessened, this is an advantage and tends to economy in steam consumption with high speeds.

The late Mr. Willans made some very interesting experiments with a view to finding the effect of high speed on initial condensation, and he found that in an engine running at 100 revolutions per minute the initial condensation was more than twice as great as in the same engine running at 400 revolutions per minute.

The mechanical efficiency has been shown to equal that of the slow speed engine, and, as I have already pointed out, the automatic expansion governor is the most economical in steam consumption except at light loads when throttling has the advantage, but as most shaft governors do a bit of both, I think I shall not be far out in saying that a high speed engine with an automatic shaft governor, and fitted with the best lubricating appliances, is quite equal to any slow speed engine as regards economy in steam consumption per brake horse-power.

THE NEW METHODS OF THE INSTITUTION OF CIVIL ENGINEERS.

The syllabus of examination for entrance has now been issued by the Institution of Civil Engineers. That for students is distinctly of the scholastic type, and may strictly be said to demand that students shall endeavour to obtain entrance quickly. The students' examination will discourage the entrance of the young man who has been compelled by circumstances to go into practical work very early. There are five papers to be got through. English: a general paper in geography, history, and literature; two mathematical papers, and two other papers, of which only one may be a language paper, to be selected from the following:—Latin, Greek, French, German, Spanish, Italian, elementary physics, elementary chemistry, geometrical and freehand drawing.

There are certain qualifying examinations which are allowed wholly or in part to exempt the student wholly or in part from the examination, he being obliged only to complete such portions as are not wholly covered. These qualifying or exempting examinations include the moderations examinations of our two leading universities, London matriculation, several examinations of various English, Irish, and Scotch colleges, &c., and many Colonial and Indian universities.

For associate members there are two papers of three hours each on theoretical and applied mechanics, and the same on the theory of structures and strength of materials, and one paper on a subject to be selected from the following: geodesy, hydraulics, theory of heat engines, metallurgy, geology and mineralogy, stability and resistance of ships, thermo and electric chemistry, electricity and magnetism.

The Council will herein also allow certain examinations to pass for righteousness. As one reads the list, the picture inevitably presents itself of an army of school lads and science teachers rioting in chalk upon the black board of the Institution, while a crowd of competent and otherwise engineers are left outside. What is the Council going to do to admit the outsiders of engineering ability, who would be absolutely floored by even the student's examination. It has been said that our columns bear hardly upon professors. This had almost prevented us from saying that professor is writ large on this syllabus. In themselves the examinations are not difficult. That for students could be passed by even the classical side scholars of a public school, with a little extra working at, say, physics or chemistry. Possibly it is the aim of the Institution to catch its subjects young. Yet to-day, more than ever, some of the best engineers have become so at an advanced age. Was not Lord Armstrong himself trained to the law, and are there not very large numbers of men who continue to develop late in life? This quite common trait of character cannot have escaped the notice of most observant persons. Again, quite apart from this, it is a fact that large constructive ability often exists with very small scholastic ability. Are such qualities to be rejected, and the Institution Germanised, or is the Institution of Civil Engineers still intended to include the rough material which placed English engineering at the head of the world? We use the word Germanised not in an offensive sense. We believe the Germans themselves are recognising the need of Anglicising somewhat. They begin to recognise that more is required than can be expressed in the ability to get through a number of examination papers.

The tendency of the Institution's examination is to narrowness. The successful student will be a specialist, so to speak, in the cradle. Now, specialism will make money for a man, and enable him to reach a higher pinnacle of success in life as usually understood; but we very much question the desirableness of encouraging the special bent so early. Such an experiment as this new move of the I.C.E., unfortunately, takes years to work out. Probably one of the first results will be a series of books for use of aspirants wherewith to cram for examination.

Since writing the foregoing the syllabus has been published, and the *Engineer*, having learned that misapprehension exists on the subject, has gone to the trouble of finding out and explaining that the old system or entry still stands good and the untutored yet able engineer can still gain admittance by works if not by faith. The new regulations are, in fact, simply a recognition of and putting in force a certain neglected section of an old bye-law. Our contemporary suggests that the examination papers should contain a large number and a wide range of questions, and the candidate should be confined to a few only which he can choose at will. We think the suggestion a good one if any attempts are to be made by engineers in practice to enter by the new door. At the same time, in spite of the difference of facts made known since the foregoing was written, we do not see that we need expunge a word.

THE ENGINEERS' STRIKE.

The latest development of the engineer's strike, now in its sixteenth week, is the feverish anxiety of the hasty executive that someone should intervene. Messrs. Burns, Barnes & Co., commence a struggle with a light heart; they are prepared, they tell the world, to spend every penny of their members' sick fund, and now having probably done so they want to call in the Board of Trade or some Cardinal Archbishop or what not to conciliate. Why, in Heaven's name did they not ask for all this before striking. As it is they were so cocksure of certain and speedy victory that they never gave a thought then to intervention. Indeed they specially declared in August they would have no "conferencing," &c. Now that they are afraid they are beaten, they call the employers inhuman for not running gladly to a conciliation meeting. Can inconsistency go further? The plain unvarnished fact to day, however unpalatable it may be to the men who have allowed Messrs. Burns and Barnes to lead them by the nose like sheep, is that the A.S.E. has gone out of its way for years past to harass, hamper, and insult all engineering employers until it has compelled them to federate. The A.S.E. has raised a demon and like Frankenstein cannot lay him.

Attention is powerfully directed upon Birmingham. If the employees at Birmingham were to join the Federation, it is thought by the *Engineer* that the end would be hastened. The breaking away of the boiler makers from the control of Mr. Knight and their starting a strike will deprive the A.S.E. of a source of funds. A few more such additions to the strike roll would complete the disaster and the A.S.E. would have reached the end of a long and mischievous career. Let us hope it would arise purged of its unprincipled elements. Trade is good in Birmingham and we understand that there has been less officious interference there by the A.S.E., but the Birmingham employers are wondering how they will get on if the rest of the country is compelled to adopt eight hours and they are beginning to think they had best help now or they may be crushed in the future. As much capital as possible has been made of the misreported interview in which Mr. Siemens was made to say he wished to abolish the unions altogether and every endeavour is being made to concentrate public attention upon this and also upon the question of eight hours, which, as confessed by one of the strike leaders, has been pushed to the front as a popular issue to obscure the machine question, which is really the issue of the struggle. If the men win, the machine question will become prominent. If the men lose the machine question will be settled, and we venture to predict that as business recovers from the shock, the settlement of this vexed machine matter will admit of such an increase of business that the eight hours movement will settle itself. We must confess that it is with a feeling of impatience that we read the self-sufficient speeches and misstatements of men like Barnes and Burns. One could almost imagine that the object of these men is as much the destruction of machinery as was that of the Lancashire mob who wrecked the early spinning machines because they imagined such machines would displace labour. After a century of experience during which the spinning machine has grown from a hand frame of a single spindle to a power driven frame with over a thousand spindles in a row, it might have been thought that machinery would have received tolerance. It is not so however. The Amalgamated Society of Engineers do not, it may rightly be argued, object to the use of machinery, but they do object to its being used in such a way that it will do more work than can be done by a man with a hand tool. In the very first lathe one man had necessarily to attend wholly upon it for he was the tool holder. He was in the position of the spinner who could make but one thread at a time. The lathe with the human tool holder was on a par with the spinning wheel. The spinning wheel has grown into the twelve hundred spindle mule, and a Lancashire minder, as the spinners are called, would call anyone demented who proposed to reduce the number of spindles in a frame, or reduce the length of "draw" or the number of draws per minute. As to piece work and day work and the payment of labour in the cotton trade, what do we find in this most automatic of all trades which makes the biggest use of machinery. We find that the highest paid men in the cotton mills

are those who are paid on a rigid system of piecework; that the women on piecework are not only socially superior to the day work hands but much better paid, and generally that the day work throughout is the worst paid, and a Lancashire factory worker would laugh at anyone who was such a fool as to condemn machinery. Even the children know better than the executive of the A.S.E., for these men confine a turner to one lathe and limit the number of tools to one on a lathe. The turner stands where he did a century ago, while the spinner, who attends now to two machines in place of one, has over 1,000 tools (spindles) in each machine. The spinning frame minder has a man or two and a boy to assist him, and may be compared with an ideal lathesman who, himself thoroughly skilled, should have half a dozen lathes under him and two or three less skilled youths to help him. Does anyone who is not a fool think that such a system would reduce the number of skilled men to be employed? Does anyone but a fool think that the "Victory" or other more recent printing presses has reduced the working staff on London's daily press? Yet it is entirely on such suppositions that the A.S.E. have entered on their present struggle, and it is to limit the output of machine tools that the public are being asked to subscribe money to help men to remain idle and to glorify the Stamford Street executive. We feel that we are writing the veriest platitude in pointing out the advantages of machinery. We would not tell a twice told tale but that, plain and simple as it is, it is not so to the misguided victims of John Burns and his colleagues. One expects intelligence from engineers: there is more sound common sense in a dozen Lancashire factory girls than in the whole Union of London engineers. One knows how to profit herself out of machinery; the engineers have yet to learn the lesson. We find a section of the boiler makers objecting to the use of electrical drills and other appliances. "Fairplay," quoting a Chicago shipbuilder, says "that all drilling and caulking is paid for by the piece, except the gunwale bar, which being heavy and particular work, is done by the day. Other piece-work is done by contract, as, for instance, 75 cents per plate for shell-plating, including laying-out and templet work. The rest of the handling is done by labour-saving machinery. Deck and other plating is also done by contract. In the machine-shops so much machinery is used that piece-work is not so common, but, says our informant, 'We do not have any trouble in using handy labourers to work improved machines, which do not require skilled attendants.' It is needless to point out how different this is from the experience of British engineering employers, who have to contend with the absurd claim of the A.S.E. to attend machines which a boy can manage as well as a skilled artisan at full artisan's wages. It would be short shrift in any American engine-shop for any man who interfered with the working of any other man, were he unionist or labourer."

Burns has called for American methods; he did so entirely without knowledge of what American methods mean. He raised his cry apparently to throw dust in the eyes of the public and to discredit the employers, as not knowing how to work on modern methods. It is a fine and high sounding phrase is this one of American methods; it may mean anything; it really does mean the very opposite of all that Burns has professed to be fighting for; it is the very negation of the restrictive methods of the A.S.E. Either Burns will have the opportunity soon of learning what these methods are, or he will see imported even more of the productions of America than he can see to-day.

CORRESPONDENCE.

Fault in Dynamo.

I should be glad if any of your readers can inform me what I can do to get rid of a rather curious fault in dynamo. The dynamo is compound-wound, output 120 amperes 60 volts at 240 revs., and is coupled direct to vertical engine; diameter of armature shaft, 3½ inches. When dynamo is at rest the distance between armature coils and magnet poles is equal, there being about ⅛-inch air gap; such is also the case when machine is running at half or full speed, but not excited. Directly the machine is excited the armature commences to almost touch the edge of top magnet pole; in fact, does touch if 60 volts is reached. The rubbing is not so noticeable when machine is loaded, but voltage not exceeding 50 volts. On turning off current or breaking shunt circuit it runs perfectly central again.

The machine has been running about 10 months, and has worn away three entire sets of journals. I enclose makers name of dynamo, but not for publication.

A.I.E.E.

[The fault is in all probability due to inequality in the magnetic flux in the air space, and may be caused by the field coil farthest away from the point touched being weaker than the other coil. We advise you to communicate with the makers, or call in a qualified electrician to test the dynamo. Without an examination of the machine it is impossible to say what should be done to remedy the fault; if the weak coil is internally short-circuited, it will require rewinding.—Eds. Elec. Rev.]

"Wireless Telegraphy."

In your interesting article on this subject in your issue for the 8th inst., you say: "We think there can be no doubt that Marconi is the true and first inventor of the elevated electrodes on the receiver and transmitter."

In a book entitled "The Inventions, Researches and Writings of Nikola Tesla," published early in 1894, pages 346—9, will be found much interesting matter with regard to what is therein termed "the transmission of intelligible signals, or perhaps even power, to any distance without the use of wires." In particular, an arrangement of transmitter and receiver, each connected with one terminal to earth, and with the other terminal to an insulated body of large surface, shown in a diagram as elevated above the earth, is suggested for the purpose of what is indexed as "telegraphy without wires."

Without in any way desiring to detract from the credit that is due to Mr. Marconi for the results that he has obtained, I think that it is only fair to Mr. Tesla that attention should be called to the above.

A. A. C. Swinton.

As I witnessed all Prof. Minchin's experiments at the time of which he speaks, I can fully testify to his priority in the use of the "collecting wire." I have no difficulty in calling to mind his apparatus. One terminal of the "impulsion" cell was connected to earth, so, also, was one terminal of the Clifton electrometer. The other terminal of the cell was joined to the second pair of quadrants, and from this same terminal the "collecting wire" protruded into space, as a "feeler" for the Hertz waves. It was a stout wire, several feet long, supported on wooden stands.

With this apparatus we carried out a system of wireless signalling through a distance of about 100 feet: that is to say, from the laboratory, across the lawn, to Sir Alexander Taylor's tennis courts, and we noticed that the effect was only partially cut off by the wire netting that bordered the courts. Again, we signalled through a series of rooms, *i.e.*, from the lecture room (Hartington) to the further laboratory, all the intervening doors being shut. This was seven or eight years ago.

Hence it is clear that Prof. Minchin not only preceded modern experiment in adding a "collecting wire," but also in the device of earthing the second terminal.

Rollo Appleyard.

October 18th, 1897.

Galileo Ferraris Memorial.

I am instructed by the Council of this Institution to request the favour of your allowing them to make known through your columns that they will be happy to take charge of and remit to Milan the subscriptions of Members of the Institution towards the fund being raised for the purpose of erecting a monument to the memory of the late Prof. Galileo Ferraris.

Such subscriptions should be made payable to and addressed to the secretary of the Institution of Electrical Engineers.

F. H. Webb,
Secretary Institution Electrical Engineers.

October 15th, 1897.

High Voltage Lamps.

Much has been written in your columns about high voltage lamps by various electrical engineers. Perhaps it may interest your readers to know how these lamps are viewed from the consumer's point of view.

Formerly I used a considerable number of 5 and 8 C.P., 115 volt lamps, separately switched, which answered the requirements in certain parts of my house very well. These lamps were good, lasted well, and were economic of current. Now I have had to replace these with 8 C.P. 230 volt lamps, as 5 C.P. lamps are not obtainable at this voltage. These I find are very inferior in lasting power, and soon dull down and blacken or break. So much so do I find this to be the case, that I am gradually replacing them by 16 C.P. lamps where the filament is not so fragile, and thus reducing the cost of renewal at the expense of my current bill.

Where fittings require the lamp to be placed at an angle, especially if liable to any vibration, the filament tends to bend over until it soon touches the glass. I am aware that this happens at all voltages, but the rapidity with which the glass is cracked in this way is infinitely greater in the 230 volt lamps than in the 115 volt lamps. Even if the lamp be placed perpendicularly upwards it does not last as well as if hung downwards.

I have used about equal numbers of Ediswan and Stearn lamps. The former are better finished and in every way pleasanter lamps, to me, at any rate, for 16 C.P. and upwards. The latter, I think, have a slight advantage below 16 C.P., owing to the filament being rather more rigid than in the Ediswan. The Robertson, a thoroughly good low voltage lamp, is not yet up to the mark in high voltages, so far as my experience goes. The Sunbeam I have seen but not yet tried.

It will, of course, be understood that I have accepted the voltage supplied to me as correct and the lamps as correctly marked, not having appliances for verifying these data.

The result of my experience is, therefore, that I am paying for more current, paying more for renewals, and against this I am getting the advantage of the cheaper production of the electric energy at 230 volts. I doubt whether the net result is in my favour. There are various other drawbacks from my point of view, but I need only mention that I find when a lamp goes on the 230 volt circuit it almost always causes the branch fuse to blow which, to say the least of it, is a considerable nuisance.

Civis.

Edinburgh, *October 18th*, 1897.

Julius Sax & Co., Limited. Sax, Slatter & Co., Limited.

I observe in your issue of the 15th inst. a letter from Mr. Alfred Slatter, which calls into question the accuracy of a letter from Julius Sax & Co., Limited, which appeared in your issue of the 1st inst.

With a view to removing any misunderstanding which may exist in the minds of your readers as the result of apparently conflicting statements, may I be permitted to state the actual circumstances.

About two years ago Julius Sax & Co., Limited, established a branch business at Forester's Hall, Clerkenwell, for the sale of cheap and mainly foreign made electrical goods. This new department was worked as an independent business, and owing to its nature, has not at any time acted in competition with the manufacturing and contracting business with which our name has been associated for the past 42 years.

For various reasons the directors of Julius Sax & Co., Limited, decided to discontinue this branch business, but, at the request of the late manager (Mr. Slatter), the goodwill was recently assigned to him, and he took over the stock. Julius Sax & Co., Limited, have never repudiated this sale, and have no reason for desiring to do so.

The letter from Julius Sax & Co., Limited, which appeared in your columns, was merely intended as a notification that, although Julius Sax & Co., Limited, have discontinued to carry on the business at Forester's Hall, they still continue to carry on the business of electrical engineers and electric light contractors at their works, 119, Coldharbour Lane, S.E., and to prevent any assumption that Julius Sax & Co., Limited, had parted with their business.

Mr. Slatter states that the matter has been placed in the hands of the solicitor for his company to deal with. Permit me to say that prior to the appearance of the letter in question, Julius Sax & Co., Limited, had instructed their solicitors to prevent any representation that Sax, Slatter & Co., Limited have succeeded to the business of Julius Sax & Co., Limited.

Will you kindly, in justice to my company, insert this letter in your next issue?

For **Julius Sax & Co., Limited.**
E. M. Winter, *Manager*.

Lectures.—At the Ventnor Literary Institute, on Friday last, Dr. Fison lectured on "The Electric Current and its Modern Applications." This was the first of a series on this subject.

THE LOCALISATION OF A TOTAL BREAK IN A CABLE.

In the *Electrician* of October 15th appeared a long article from the pen of Mr. Schaefer, of the Eastern Telegraph Company, on a method of localising total breaks in cables. The subject, already of much importance, acquired new interest after the announcement of Mr. Kennelly's "law" in 1887, and Mr. Schaefer's paper promised at first sight an interesting development. To make our observations on this paper clear, we may state shortly the nature of the problem presented to the electrician by a broken cable, and the method of its solution.

The conductor of the cable is found on trial to be connected to earth at some distant point, and is totally disconnected from the other end. What is the resistance to the break?

We have three unknowns: (1) The resistance of the conductor to the break; (2) the electromotive force due to earth currents and polarisation acting in the circuit composed of the conductor and the earth; (3) the condition of the surface of the conductor at the break. To obtain a solution three measurements are required, giving rise to three equations. The methods employed by Mr. Kennelly to form these equations is as follows:—A battery of known electromotive force is connected in the circuit, the resulting current measured, and the fall of potential along the circuit due to the three unknown quantities stated as a function of the current is equated to the electromotive force applied. From Ohm's law we know that the fall of potential due to the resistance of the cable is the product of the resistance and the current. From the known properties of electrolytic cells and the character of earth currents, the fall of potential due to earth current and polarisation is assumed to be independent of the current. As to the fall of potential due to the condition of the fault we can at first say nothing. If it were due to a quality such as a fixed resistance, we could assume it to be proportional to the current. If it were due to a back electromotive force we could assume it to be constant; but the circumstances of the case do not justify either assumption. At this point Kennelly's rule assists us. He found that the results of observations are satisfied by assuming that the fall of potential at a fault is proportional to the square root of the mean current density over the exposed surface. This is not the form in which his rules—we dislike the use of "laws" in such a case as this—are commonly stated, but they amount to this and to nothing more. The relation between the quantities now stands thus. Where E is the known electromotive force of the battery, C the observed current, ρ the resistance of the cable to the fault, e the electromotive force due to earth currents and polarisation, a the area of the fault. We have

$$E = e + k\left(\frac{C}{a}\right)^{\frac{1}{2}} + \rho C$$

E C being observed, and e, a, and ρ being unknown.

It is now only necessary to arrange three sets of values for E C, and to solve for ρ between the three equations obtained.

For the determination of ρ the physical meaning of a is of no importance, since it is eliminated in the solution, and we may write

$$E = e + \beta C^{.5} + \rho C$$

where β is some unknown quantity independent of C. That $\beta \propto$ the reciprocal of the root of the exposed area is interesting, but has no significance in the determination of ρ. So far Kennelly.

Mr. Schaefer finds that if the assumed fall of potential at the fault varies as the ·23rd power of the current density at the fault instead of the ·5th power, the relationship between observed quantities is more exactly represented. His primary equation is equivalent to

$$E = e + \gamma C^{.23} + \rho C,$$

γ being proportional to the reciprocal of the ·23rd power of the exposed area; so that $\gamma C^{.23} \propto \left(\frac{C}{a}\right)^{.23}$ This is the discovery. His method of ascertaining the value of e by an independent experiment, so that only two sets of values of E,C, are re-

quired for the solution, is a matter of convenience in practice with which we are not at present concerned. We have no doubt it is a convenient method of procedure.

Empirical formulæ in dealing with physical questions of this kind are often very useful, and it is common to find several different expressions that equally well represent a set of ascertained facts. We should not be surprised to learn that equally useful results are obtained, perhaps with different ranges of current density at the exposed surface, from the expressions of Kennelly and Schaefer. But Mr. Schaefer claims, somewhat imperiously, to set aside Kennelly's expression and substitute his own, on the strength of certain experiments which do not appear to have been published. His paper does not contain material which might enable us to form any opinion of the relative values of his and Mr. Kennelly's rules. The figures of Table II. in the paper under notice appear to indicate that the rule is closely correct in a particular case for currents from 4 to 15 milliamperes, but obtained, as they are, by the application of a purely hypothetical correction of as much as from 20 to 25 per cent. to the observations of other persons, they are valueless. The figures of Table I. are not corrected for the effects of earth current and polarisation, and do not seem to be seriously advanced as evidence. On the other hand, it is within the knowledge of ourselves and others that accurate and consistent results have been obtained with Kennelly's rule under laboratory conditions which admitted verification of all the quantities dealt with.

Thus, while we readily admit a *primâ facie* probability that Kennelly's rule may be superseded by a more useful expression, we are far from satisfied that Mr. Schaefer has found it.

We have, moreover, positive fault to find with the paper. We cannot blame Mr. Schaefer for following current, and indeed eminent, practice in not restricting the term "resistance" to cases in which electrical energy is converted into heat at a rate proportional to the square of the current, but risking the charge of pedantry, we express the opinion, which we have expressed more strongly before, that this looseness of language is often concomitant with much looseness of thought. The other complaint we have to make is more serious, but our appreciation of the undoubted ability of Mr. Schaefer's work restrains us from characterising as we are tempted to do, the mistaken pretension that announces an empirical modification of Kennelly's rule, as a new and connected body of physical law.

PROFESSORS AND ENGINEERING.

If there be one thing more apparent than another, it is that the engineering professor is very apt to go out of his way to prove things experimentally which he can and ought to show on paper must be facts. We are led to make this remark having been accused of unfairness to the professorial cult, by a report in the *Scientific American* of certain tests on a locomotive that have been made at Purdue University.

Bent rails, bridge vibrations and the observed earth vibrations from passing locomotives, have all shown plainly and unmistakably that locomotives balanced fully for both revolving and reciprocating parts are very seriously out of balance vertically. Every student of mechanics has known this as soon as he has given any attention to the subject of machinery balance. It is plain and obvious that a weight cannot be revolved with a wheel without producing a varying pressure on the rail. With a well designed English locomotive, which includes reasonably light reciprocating parts, the centrifugal effects are very much less than they are in American practice, which is careless of design in these important matters, and runs high speeds with small wheels. In America, therefore, the bad effects of the vertical non-balance have been, at times, very marked. At the Purdue University they have gone so far as to experiment on locomotives of ordinary type and of a four-cylinder type in which the pistons on each side move oppositely to each other and obviate the need of revolving weights, the reciprocating parts being, of course, self-balancing on each side of the engine. In making the tests a wire of circular section has been run between the locomotive wheels and the friction wheels, on which these run in place of a rail, and with an excess of 400 lbs. it was found that the wire was much flattened in places by its passage under the wheels, and that at certain speeds it was found still perfectly circular for even several feet, this latter fact being taken to show that the wheel must have been actually lifted off the rail for a considerable part of its revolution. The flattened wire corresponded with the down position of the balance weight, and the full circular shape with the up position. For the mere experimental teaching of a lot of lads this experimental locomotive is all very well, and these particular experiments form a neat way of showing the effects of systems of "balancing." But of what we complain is, that the experiments have been put forward as though they were necessary to prove that the system of balancing reciprocating parts has the effect of throwing out the vertical balance. If the study of mechanics be worth anything, if the engineering professors are worth their salt, they ought long ago to have insisted that locomotives would act just as they have done. It looks odd, to say the least of it, that the *Scientific American* should say that "this variation of pressure of driving wheels on the rails" was "suspected," as though the familiar formula for centrifugal action, viz., ·00034 W R N², were a very doubtful matter indeed, and could not be relied on. If our books on mechanics are worth anything, there is nothing easier than to show that the centrifugal action of locomotive balance weights may easily exceed the load carried by the wheel, and, therefore, the wheel must, for the moment, carry the locomotive without itself resting on the rail. If it were not so, then do weights revolving in practice differ from either book weights or weights in the laboratory. These Purdue University tests are all of a piece with that backwardness of our supposed teachers who, while athletes in mathematics, seem able only to fit their mathematics to proved facts in place of teaching how to avoid costly experiment. In the workshop a machine is drawn on paper and made in wood and metal, because it is cheaper to use paper than to use wood, and we cannot afford to first cut and try in materials and then make our drawing from the machine. We make a machine from the drawing. In the professors' world the drawing is made with great show of theory and figures from the laboriously hewn out machine of the practical man. This is not as it should be. The duty of an engineering professor is to find rules to guide practice, not to smother practical discoveries with incomprehensible mathematics. In regard to this very question of locomotive balance, we have before us as we write the *Journal* of the Franklin Institute for January, 1887, in which the hammer blow of the locomotive is recognised and treated of almost without mathematics, and the conclusions now arrived at are proved. After all this lapse of years we are told the action was suspected, and a teaching professor has to make an experiment to show that centrifugal force, as taught for years and years, is actually an active entity. Now they have found it out the theory will be all nicely done into symbols.

To have built a locomotive with four cylinders to show how the fault can be overcome, is even a more heinous error. Everyone who knew anything at all must have known beforehand that the arrangement practically would solve the difficulty. But a professor must let this expense be incurred.

We might as well destroy all literature at once if this sort of thing is to prevail.

As to their value to students, the whole thing could be shown with a small model made for a few shillings.

THE DETERMINATION OF THE SERIES WINDINGS FOR A COMPOUND DYNAMO.

By LAWFORD H. FRY.

Having a shunt wound dynamo, either constructed or merely calculated, to determine the number of series windings which must be added to the field magnets to keep the potential constant and independent of the load.

This problem is not capable of absolutely accurate solution, but in a good compound dynamo the variation of potential will not exceed 3 or 4 per cent.

Considering such a machine, which is driven at constant speed, we may assume that the terminal potential, which we will henceforth denote by k remains constant. Hence the

current through the shunt coils will remain constant. This current will, in future, be denoted by C_n. Now, if we have a normal armature current, C_a, and a normal current, C, in the external circuit, so that $C_a = C + C_n$, we can consider the terminal potential, k, as made up of two components, viz., k_n the potential due to the shunt coils, and k_s the potential due to the series coils,

then $$k = k_n + k_s,$$

and with no armature current we should have $k = k_{no}$.

The shunt coils being so calculated that they give us the normal potential when there is no armature current.

That k_n is less than k is due to two causes.

(1) To the loss of potential by reason of the resistance of the armature coils.

Represent the potential thus lost by k_1, then if the armature resistance is a, we have $k_1 = C_a \times a$.

(2) To the armature reaction.

Represent the potential lost through this by k_2

then $$k_1 + k_2 + k_n = k,$$

or $$k_1 + k_2 = k_s.$$

If we have a constructed dynamo we can, as we shall see below, at once measure k_s, and hence determine the required number of coils; if, on the other hand, we have only the calculations for a dynamo, we must divide our work into two steps, corresponding to the two sources of loss of potential.

We have now to obtain a relation between the E.M.F. of the machine and the number of ampere windings on the magnets. If the calculations of the machine are before us, we have, of course, this relation; if, on the other hand we have the completed dynamo we may make use of Fröhlich's theory of the dynamo to help us out. Fröhlich puts

$$e = f \cdot \mathrm{M} \cdot v$$

where f is a constant, v is the number of revolutions of the armature in a minute, and M is an expression for the magnetism of the machine, viz.:

$$\mathrm{M} = \frac{\mu \cdot \mathrm{N} \cdot C_n}{1 + \mu \mathrm{N} C_n}$$

where μ is a constant, and $\mathrm{N} C_n$ represent the ampere windings on the field magnets.

Now since v is to be constant we may write

$$e = \mathrm{P} \cdot \frac{\mu \mathrm{N} C_n}{1 + \mu \mathrm{N} C_n} \qquad (\mathrm{A})$$

P being a constant.

$$\therefore \mathrm{N} \cdot C_n = \frac{e}{(\mathrm{P} - e)\mu}.$$

We have here two constants, P and μ, to determine. To do this, take our ordinary shunt dynamo, disconnect the magnet coils from the brushes and connect them with some other source of current, as for instance, a secondary battery. Drive the dynamo and make two measurements of the potential difference between the poles, with two different currents in the magnet coils. Let one of the measurements be at normal potential, k, and consequently with normal magnetising current, C_n.

If we insert the values thus obtained for e and C_n in the equation A, we shall get a pair of simultaneous equations for P and μ. Now reconnect the magnet windings with the brushes and drive the dynamo as an ordinary shunt wound machine. Load it up to the current, C, which is to be normal for the compound machine at the same time regulating the shunt resistance till the current in the shunt has its normal value C_n. Measure the terminal potential. Suppose it to be k', then the difference between k and k' is the potential we have to make up by means of the series coils, *i.e.*, $k - k' = k_s$.

Then if N_s represent the number of series coils required, we shall have from equation A

$$k_s = \mathrm{P} \frac{\mu \mathrm{N}_s \mathrm{C}}{1 + \mu \mathrm{N}_s \mathrm{C}}.$$

In this equation we know everything except N_s, which can thus be easily determined.

Now for case of dynamo, of which we have only the calculations.

First: to determine the series windings necessary to make up for the loss of potential due to current in the armature windings. This potential was represented above by k_1. The calculations will give us the number of windings, suppose it to be N_1, which, carrying the current, C, will give us this potential.

Secondly: to determine the number of windings required to counteract the armature reaction. This we calculate by the formula given by Dolivo Dobrowolski. If $\mathrm{N} C_n$ be the ampere windings required to produce the normal potential, k, with no armature current. Let $\mathrm{N}_a C_a$ be the number of armature ampere windings, and $\mathrm{N}_1 C_1$ be the ampere windings necessary to produce the potential and overcome the armature reaction. Then $\mathrm{N}_1 C_1 = \sqrt{\mathrm{N}^2 C_n^2 + \mathrm{N}_a^2 C_a^2}$ according to Dolivo Dobrowolski. From this we can calculate $\mathrm{N}_1 C_1$, now we have already on the magnets, $\mathrm{N}C_n$, ampere windings so that the number we have to add is $\mathrm{N}_1 C_1 - \mathrm{N}_n C_n$, and the current in these will be C, so that if we represent the number of series windings required to overcome the armature reaction by N_2, we have $\mathrm{N}_2 \mathrm{C} = \mathrm{N}_1 C_1 - \mathrm{N} C_n$

$$\therefore \mathrm{N}_2 = \frac{\mathrm{N}_1 C_1 - \mathrm{N} C_n}{\mathrm{C}}.$$

Thus the whole number of windings to be added will be $\mathrm{N}_1 + \mathrm{N}_2$.

The method set forth above will give approximately the number of ampere windings required, and a few tests with the completed dynamo will show whether the addition or removal of a few turns of wire will give a better result.

DEFECTS IN STEAM BOILERS.

The Austrian Society of Engineers and Architects have published a second report on "Steam Boiler Defects," well illustrated with typical defects and with notes on the cause and prevention of various forms of corrosion.

Under the head of "External Corrosion," there is the local rust often caused by the condensation of moisture upon the cold boiler. This moisture collects in the brickwork and causes rusting of the plates in contact therewith. The consequences of this corrosion may be very dangerous. For its prevention is recommended clay mortar with a final layer of asbestos, and the insertion of iron plates between the wall and the boiler; also draining of the bottom flue and frequent drying out of the flues by heat. Of these remedies, clay mortar should always be used next to plates. Lime has a peculiarly destructive effect when wet. Bottom flues ought not to need draining. A boiler ought to be set upon a concrete bottom where dampness is suspected.

Rusting of plate edges and rivets by the action of the sulphuric acid from the fuel and especially from the quenching of hot ashes in front of the boiler is to be prevented by stopping this bad practice and by keeping things dry. If this acid collects in its earlier forms of SO_2 or SO_3 upon the external covering, it is harmless while dry. Lime in the boiler covering neutralises it with, of course, the formation of sulphate of lime. Lime thus used must not become wet or it will itself act corrosively. Small leaks are powerful aids to the corrosive action of the sulphur acids. Such leaks often occur at circular seams, and in the corners of the overlaps, and it is surprising how large a mass of rust will accumulate from a very little wasting of a plate—enough to scare a novice who can hardly credit that an inch thickness of plate rust represents so small a wasting of the plate. The mischief with these little leakages is that though only local, and often of no serious weakening effect, they may render the plate difficult to caulk, and end with a job at patching. Badly fitting mounting blocks or flanges are again a great source of small leaks, and where cast-iron is employed a wrought-iron plate should be interposed. The illustrations show pipe flanges attached without special mounting blocks, a practice never now followed in English work. Under the head of internal corrosion there is the unfamiliar corrosion just above water level, caused by two high flues exposing plates to fire on one side and steam on the other. It is recommended that no flue should be less than 4 inches (10 cm.) below the water level, and that the limit line externally should be painted on a new boiler by the maker. This corrosion is, of course, due to the overheating of iron in contact with moisture, and it may become serious. There was once a boiler at a Wakefield cornmill which was pitted with corrosion all over the crown in the steam space, and was apt to be a puzzle to new inspectors. This boiler, however, had been turned half round and the old corroded bottom plates became the boiler crown. In boilers with a lower drum entirely full of water, steam may be trapped in by the overlap of the plates, and the plates at the point where this steam is, may be overheated and corrode as a consequence. In a telescopic boiler the water drum ought to incline 1 in 50 to allow the steam to escape. Only a small area of each plate will then have steam accumulations against it, and, presumably, the plate will cool by conduction.

The pitting of plates opposite lines of seating is caused by the greater coolness at these loci and the longer presence of occluded

gases in the water, and probably we might add to the different parts of a hot and cold plate being electro-positive or negative, ending in the corrosion of the less favourably situated portions.

Other inside corrosions from outside causes are the groovings opposite the edges of supporting brackets. There are so many variations of "grooving" caused by alternate to and fro bending. The corrosion is the more severe because the plate is under stress and the constant movement exposes continually fresh surfaces.

Grooves may be checked or they may be covered over to prevent extension. Where a boiler hangs by a bracket we think it ought to have a reinforcing plate of some area well thinned down towards its edges so as to moderate the suddenness of change of thickness, and distribute the bending over a considerable area.

Cracked overlaps to rivet holes are often structural, frequently also due to sudden cooling as about the fire-door, and are common in the ring seams of furnaces. They may be frequent enough in a tension seam to be dangerous.

The reference to longitudinal seams in furnaces being placed below the grate level seems to evidence a poorish standard of boiler making in Austria, so many of the defects named in the report being connected rather with the details of inferior work and design. The defects due to faulty construction are those due to working plates at a blue heat, bad caulking, and sudden cooling which may cause cracks in a plate. The use of steel of too high a tensile resistance is undesirable. Patching of a cracked plate is undesirable. A crack should condemn the whole plate. Blisters are pronounced very dangerous because the defective plate becomes red hot. This is hardly so. One lamination burns away, but the other, that next the water, does not, and a blister is by no means necessarily dangerous when not of large area. The report is clearly very suitable to the needs of the class of boilers which come under its scope, but as we have said it bears evidence of a not very high state of the boiler-makers art in Austria.

BUSINESS NOTICES, &c.

Electrical Wares Exported.

Week Ending Oct. 19th, 1896	£	s.
Adelaide	15	0
Alexandria	18	0
" Teleg. mat.	122	0
Amsterdam	50	0
Bombay	31	0
Buenos Ayres	365	0
" Teleg. mat.	15	0
Calcutta	47	0
Cape Town	282	0
Christiania. Teleg. mat.	50	0
Christchurch	16	0
Colombo	106	0
" Teleg. mat. ...	62	0
Durban	44	0
East London	1,539	0
Flushing	45	0
Gothenburg. Teleg. mat.	67	0
Halifax	8,257	0
Hong Kong. Teleg. mat.	55	0
Launceston	116	0
Melbourne	132	0
" Teleg. mat. ...	201	0
Monte Video	141	0
Montreal	25	0
Passages	83	0
Perth	525	0
" Teleg. mat. ...	98	0
Port Elizabeth	1,069	0
Rangoon	29	0
Rotterdam	11	0
St. Petersburg	75	0
Saigon	20	0
Shanghai. Telep. mat.	69	0
Sydney	188	0
" Telep. mat ...	140	0
Teneriffe	120	0
Yokohama	240	0
Total	£14,560	0

Week Ending Oct. 19th, 1897.	£	s.
Aden	21	0
Alexandria. Teleg. mat.	25	0
Amsterdam	20	0
Auckland	137	0
Bilbao	30	0
Bombay	331	0
Boston	15	0
Calcutta	70	0
Cape Town	948	0
Cologne	1	0
Colombo	80	0
East London	26	0
Flushing	60	0
Gothenburg	240	0
Hamburg	159	0
Hobart	81	0
Lisbon	111	0
Madeira	16	0
Madras	123	0
Marseilles	450	0
Melbourne	830	0
Montreal	40	0
Ostend	30	0
Passages	197	0
Perth	13	0
Port Chalmers	543	0
Port Elizabeth	192	0
Rosario	25	0
Sydney. Teleg. mat. ...	11	0
Timara	8	0
Wellington	164	0
Total	£5,036	0

Boudreaux Brushes.—In our "Business Notice" last week, under the heading "Talcine," we stated that the Dynamo Brush Company were sole agents for Boudreaux's foliated dynamo brushes. We have now received a letter from Messrs. Le Carbone, of Westminster, stating that they have been sole agents for Mons. Boudreaux since June 30th, and that they are still acting for him.

Dining Table Lighting.—We give herewith a sketch of the arrangement which Messrs. Drake & Gorham have worked out for the lighting of dining room tables. There has been a good deal of reluctance on the part of the public to use any of the existing

DRAKE & GORHAM'S IMPROVED METHOD OF LIGHTING DINING ROOM TABLES WITHOUT PIERCING THE CLOTH.

arrangements which necessitate the cutting of the table or cloth; the D.G. system has overcome both these difficulties, and at the same time has left nothing that can be seen. The patented arrangement consists of a flat multiple connector of a special pattern, which lies in the centre of the cloth, and enables any number of adapted candlesticks to be fed from this distributing centre. The wires pass from a floor plug up the leg of the table, and thence by means of a white silk cord under a serviette to the ornamental table centre for ordinary work, or on special occasions, the serviette is replaced by a covering of flowers taken to each corner, there being, of course, a wire under only each of these. The arrangement has been thoroughly tested in practical work, and is found to be easily handled by any parlour maid, for it is specially arranged that no mistake in the connection is possible.

Business Announcement.—The business of Messrs. Edwin Foster & Son, brass and ironfounders, mechanical and electrical engineers, of Halifax, has been formed into a limited company. Shares are being offered to the trade and customers of the firm. Mr. W. H. Foster will continue the management of the same for at least the next seven years.

Copper.—The copper statistics for the middle of October shows, says the *Financial News*, a further increase in the supply, amounting to 1,286 tons, since the end of September, with a fall in price of 17s. 6d. per ton for Chili bars and G.M.B.'s. The shipments for September, according to Messrs. Henry R. Merton & Co.'s circular, amounted to 18,133 tons, or an advance of 1,665 tons as compared with the corresponding month of last year. The increase was not in the supplies from America, which, on the contrary, decreased by a few hundred tons, but chiefly in those from Spain and Portugal and Australia. While the supplies thus increased, the deliveries, probably owing in some measure to the engineers' strike, declined by 112 tons as compared with September, 1896, and by 2,755 tons as against August this year. The contraction in the deliveries may be regarded as only temporary, and it is worth noting that although for the year ended September 30th last there was an increase in supplies of no less than 41,723 tons, yet the deliveries exceeded the total of supplies by 330 tons. The forward dealings show that some recovery is expected from the present price of the metal.

Electric Clock.—A new clock was erected on the south-east frontage of Piccadilly Circus last week. The lighting is accomplished by means of a circuit of 12 tubular lamps carried along the hands themselves, and another circuit of 12 candle lamps outlining the circle of the dial, one being placed at each hour. These circuits are put across 100-volt supply, and together take only 1·2 amperes, yet the effectiveness of the method is said to be, if anything, better than that obtained by a bank of 12 16-C.P. lamps placed behind an opal glazed dial, though this would take about six times the current. This is not the only novel feature, for the clock itself is electric, and requires no winding, the old-fashioned and cumbersome mechaniam usually associated with turret clocks being entirely dispensed with, leaving only the face, the hands, and a single wheel with an electro-magnet to operate it. It is controlled by a self-wound electric pendulum in the neighbourhood, which also works a number of smaller dials on each side of Regent Street. The hands of all the dials move forward at each half minute exactly by Greenwich meantime, and the whole installation being worked by a Leclanché battery, neither the pendulum nor any of the dials require winding up. There is practically no limit to the number of clock faces, large or small, which may be operated by one pendulum, and we understand from the Synchronome Syndicate, of 53, Victoria Street, that arrangements are being made to extend the time circuit on a large scale. The inventors of the system are Messrs. F. Hope-Jones & G. B. Bowell.

Forthcoming Books.—"The Bibiliography of X-Ray Literature and Research, 1896-1897," will be published in a few days

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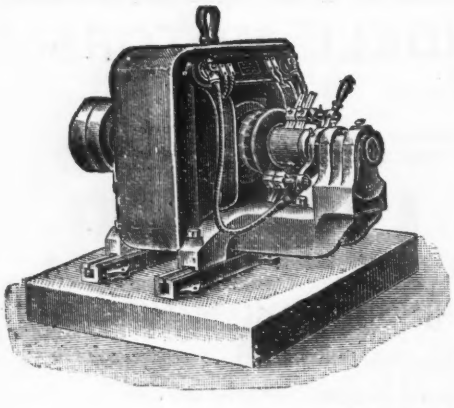

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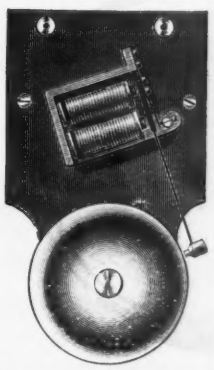

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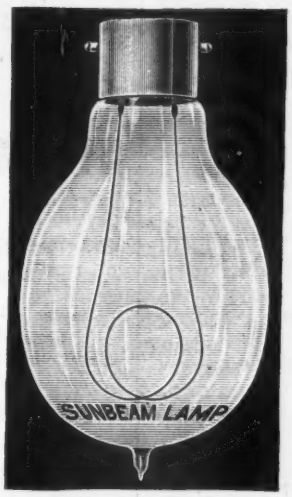

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Official Notices.

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SECTION C.
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Persons are at liberty to tender for any section or sections, but not for part of a section, and the Corporation do not bind themselves to accept the lowest or any tender.

Specifications may be obtained on application at the Electrical Engineer's Office, Montpellier Gardens, Harrogate, on payment of two guineas, which sum will be returned on receipt of *bond fide* tender.

Tenders, sealed and marked "Tender for Electric Lighting," must be addressed to the TOWN CLERK, Municipal Offices, Harrogate, and be delivered on or before 12 o'clock noon, October 25th, 1897.

By Order,
GEO. WILKINSON, M.I.E.E.,
Borough Electrical Engineer.

Montpellier Gardens, Harrogate.

1718

Official Notices.

BOROUGH OF SHOREDITCH.

CONTRACT No. 10.

THE SHOREDITCH VESTRY invite tenders for the supply and erection of additional engines and high-tension continuous current generators, with an extension of the existing Switchboard.

Specifications and forms of tender can be obtained on and after OCTOBER 8th, 1897, at the Offices of the Engineers, Messrs. KINCAID, WALLER & MANVILLE, 29, Great George Street, Westminster, on payment of a fee of £5 5s., which sum will be returned on the receipt of a *bond fide* tender.

The Vestry do not bind themselves to accept the lowest or any tender, and the contractor whose tender is accepted shall enter into a formal agreement, under seal, with sufficient sureties for the due fulfilment of his contract.

Trade union rates of wages and hours to be observed.

Sealed tenders endorsed "Electricity Supply, Tender for Contract No. 10," to be sent at or before noon on TUESDAY, NOVEMBER 2nd, 1897, to

H. MANSFIELD ROBINSON,
Vestry Clerk and Solicitor.

Town Hall, Old Street, E.C.

1738

VESTRY OF ST. PANCRAS.

THE VESTRY OF ST. PANCRAS are prepared to receive Tenders for supplying and fixing additional plant at the Regent's Park Electricity Works, comprising dynamos, engines, and switchboard.

Copies of specification, conditions of contract, and form of tender to be obtained upon application to the CHIEF CLERK, Electricity Department Offices, No. 57, Pratt Street, N.W., on payment of a deposit of £1, which will be returnable on receipt of a *bond fide* tender and specification.

Tenders to be sent to the undersigned endorsed "Tender for Engines and Dynamos, &c," by 12 o'clock noon on Tuesday, November 2nd, 1897.

The Vestry do not bind themselves to accept the lowest or any tender.

C. H. F. BARRETT,
Vestry Clerk.

Vestry Hall, Pancras Road,
London, N.W., *October 11th*, 1897.

1745

[*Continued on next Page*]

Official Notices.—*Continued.*

COUNTY BOROUGH OF BURNLEY.

TENDERS FOR ELECTRIC LIGHTING CABLES.

THE CORPORATION of Burnley invite Tenders for the supply and delivery at their Electric Lighting Station of Lead-sheathed, Armoured, Underground Cables. Specification, schedule of quantities, and form of tender, may be obtained on application to Mr. W. R. WRIGHT, the Borough Electrical Engineer, on payment of a deposit of £1 1s., which will be returned on the receipt of a *bonâ fide* tender.

Sealed tenders, endorsed "Tenders for Cables," and addressed to the Chairman of the Electric Lighting Sub-Committee, Town Hall, Burnley, must be delivered on or before WEDNESDAY, NOVEMBER 17th, 1897.

By Order,
WM. T. FULLALOVE,
Town Clerk.

Town Hall, Burnley,
October 16th, 1897.

1787

GLASGOW CORPORATION.

ELECTRICITY DEPARTMENT.

TO ELECTRICAL ENGINEERS.

THE GLASGOW CORPORATION invite applications for the position of Chief Resident Engineer of their Electricity Department. Applicants, besides possessing practical experience in all matters relating to electricity, must be specially qualified to prepare designs and specifications for, and to carry out the construction of generating stations and the laying down of mains and all other works necessary for the production and distribution of current for lighting and motive power, and to take the entire general management of the department. The salary will not be less than £800 per annum, but the successful candidate will require to devote his whole time to the duties of the office.

Applications, stating age and experience, accompanied by 20 printed copies of not more than six testimonials of recent date, to be lodged with the Subscriber, marked "Electrical Engineer," on or before 9TH NOVEMBER NEXT.

Canvassing any member of the Corporation will disqualify applicants.

J. D. MARWICK,
Town Clerk.

City Chambers, Glasgow,
October 21st, 1897.

1755

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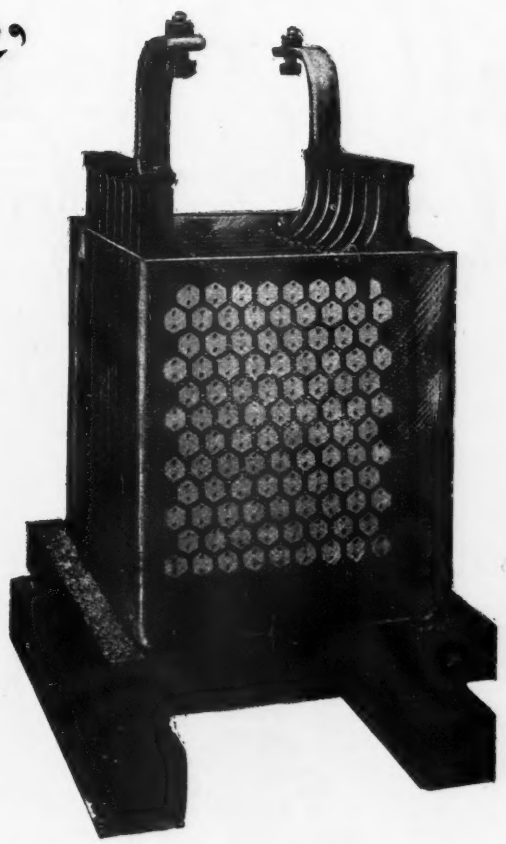

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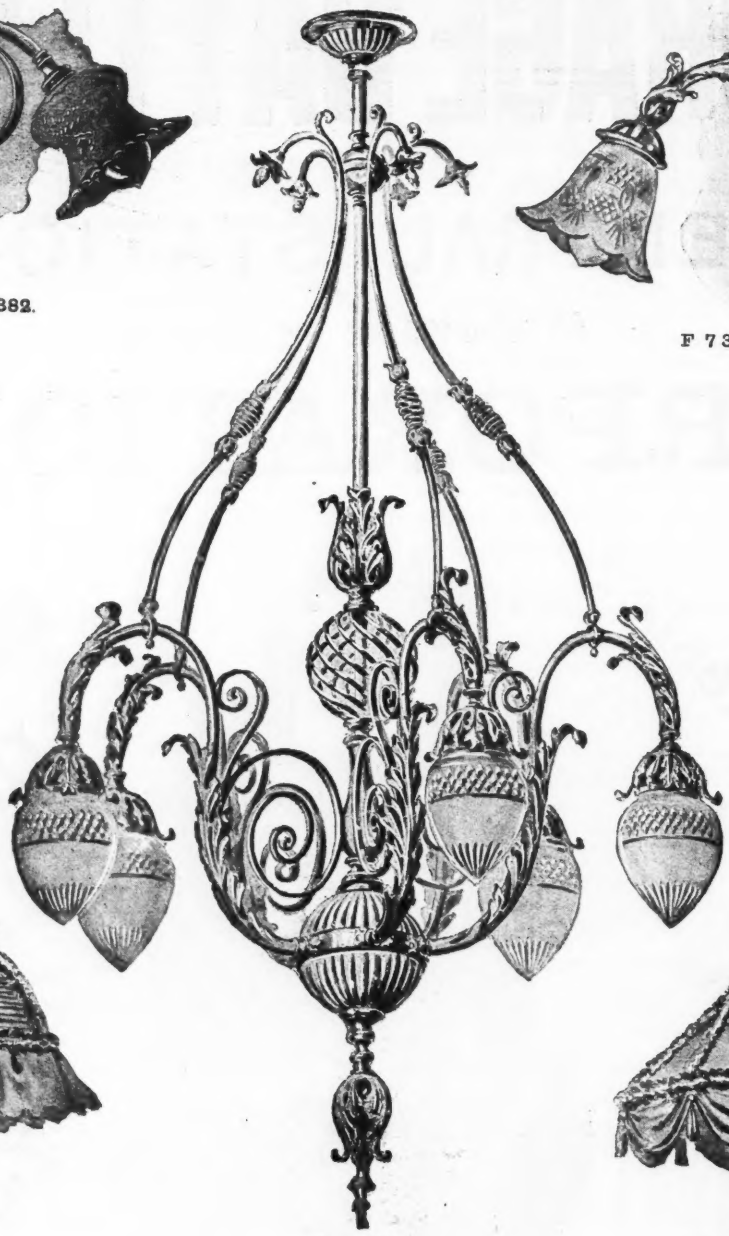

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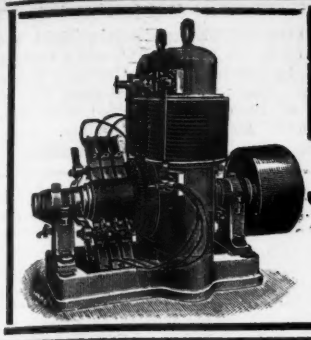

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Office: 4, LUDGATE HILL, LONDON.

TO BE OBTAINED BY ORDER FROM ANY NEWSAGENT IN TOWN OR COUNTRY

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The following are the LATEST times up to which Advertisements can be received for publication in current week's issue:—

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Original Testimonials should never be sent.

CIVIL SERVICE COMMISSION.—Forthcoming examination. Clerk in the Operative Department of the Royal Mint (20—25) November 9th. Technical training and qualifications necessary. The date specified is the latest at which applications can be received. They must be made on forms to be obtained, with particulars, from the SECRETARY, Civil Service Commission, London, S.W. 1722

DRAUGHTSMAN Required in electrical engineering works in Yorkshire, experienced in engines, dynamos, and electrical work generally.—State age, experience, and salary required, 1,763, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1763

JUNIOR ASSISTANT ENGINEER Wanted for Installation Work, one having practical and theoretical knowledge.—Apply, giving references, age, salary required, to 1,776, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1776

REQUIRED, the Services of a competent electrical engineer to take charge of an important supply station in the neighbourhood of London.—Reply, stating previous experience, qualifications and salary required, and enclosing copies of testimonials, to "G. S.," care of Messrs. Streets, 30, Cornhill. 1774

TRAVELLER Required by a firm of electrical engineers to obtain orders for electric light wiring work, London and suburbs.—Apply, 1,770, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1770

TO ENGINE FITTERS.—The services of Engine Fitters are required at the Park Fever Hospital, Hither Green, Lewisham, S.E. (under the Metropolitan Asylums, Board).

Wages, 30s. per week, with board, lodging, washing, and uniform, with an allowance, to those non-resident, of 12s. per week in lieu of the emoluments of board, lodging, and washing.

Candidates must have had experience in the working of electrical engines, and be able to take charge of heating apparatus, steam-engines, and other machinery, and to do minor repairs.

Applications in writing (not personal) are to be sent to the Chief Office of the Metropolitan Asylums Board, Norfolk House, Norfolk Street, Strand, W.C., stating full particulars as to experience, and accompanied by copies of three recent testimonials, not later than Tuesday, October 26th, 1897. 1775

WORKING FOREMAN wanted (non-society) for small London switchboard works.—State wages, references, 1,698, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1698

VULCANITE.
HARBURG INDIA-RUBBER C. COMPANY.
London Warehouse: F. WINTER, 138, London Wall, Wood St., E.C.
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WANTED.—A young Electrician as Assistant in some experimental work, with condensers, must have had practical experience in alternating current and instrument work.—Apply by letter, stating previous experience and salary required, to "CONDENSER," Colman's Advertising Offices, 3, Arundel Street, Strand. 1767

WANTED.—Pupil or Improver in alternating current station, Devonshire. Good opportunity for general experience, small premiums returned as salary.—Further particulars, address 1,714, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1714

WANTED, Assistant in office of electrical manufacturing works well up in draughtmanship, with knowledge of central station work preferred.—Apply by letter only, enclosing copies of testimonials, to THE HOLLOWAY ELECTRIC SUPPLY WORKS, Bovay Street, Holloway Road, N. 1769

WANTED, Assistant Engineer to trim and keep in repair 60 arc lamps and assist in engine room. Wages 25s.—Apply by letter only, stating age and previous experience, to "ENGINEER," care of Devy & Toms, High Street, Kensington 1771

WANTED.—Wiremen accustomed to concentric work. C.C. system.—Apply 1,783, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1713

WANTED, by a leading firm of electrical engineers, an experienced Foreman for contracting work in the Midlands.—Apply, with references and full particulars of experience and wages required, 1,785, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1785

SITUATIONS WANTED.

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A.I.E.E., 8 years' experience dynamo design and construction, estimating, installation work, business experience, seeks re-engagement.—1,779, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1779

ARMATURE WINDER (Competent) wants Situation as leading hand, foreman, or otherwise.—"WINDER," 91, Linnet Street, Clayton, Manchester. 1781

ADVERTISER wants charge of private plant.—1,701, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1701

ASSISTANT ELECTRICIAN requires berth or charge of plant. 4 years' experience with steam installation in London hotel; loco type boilers; Willans engines.—1,709, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1709

CLERK, or otherwise, to electrical firm, permanency required. Six years' varied practical experience central station work; highest testimonials.—"W.," 47, Evering Road, Stoke Newington, N. 1711

ELECTRICAL ENGINEER (28) recently in charge of branch, seeks similar berth. Good business man, and experienced installation work and estimating for same.—Apply 1,733, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1733

ELECTRICAL ENGINEER (32) over 12 years' experience, workshop, drawing office, and installation work, desires position, home or abroad, good testimonials.—1,702, ELECTRICAL REVIEW Office, 4, Ludgate Hill, London. 1702

ELECTRICIAN desires employment, good practical knowledge storage batteries, general testing, switchboard work, tracing.—1,697, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1697

ELECTRICIAN, working, nine years' references, thorough knowledge of accumulators, wiring, fixing dynamos, &c., would join out-door staff with good firm, or take charge of large installation. — Address 1,724, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1724

[*Continued on next page.*]

ELECTRICAL ENGINEER, 10 years' shop, drawing office, and installation experience, at present in charge of large installation, seeks change; good references—1,778, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1778

ELECTRICAL ENGINEER, Theoretical and 10 years' practical experience, seeks appointment at home or abroad (speaks Russian).—Apply, 1,759, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1759

ELECTRICAL ENGINEER (25) seeks Appointment as assistant works' manager; six years' experience dynamo design, installations.—1,777, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1777

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WIREMAN'S Assistant seeks situation, 6d. hour.—"D. W. B.," 1, Old Kent Road, S.E. 1786

WORKING ELECTRICIAN requires Situation to take charge of installation work, plant, wiring, cells, &c.—1,780, ELECTRICAL REVIEW, 4, Ludgate Hill, London 1780

YOUNG Electrical Engineer seeks appointment as Junior Assistant, two years' theoretical, three years with leading firm, one year's central station experience; energetic. Excellent testimonials. — 1,764, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1764

ARTICLES FOR SALE AND WANTED, PARTNERSHIPS, &c.

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ELECTRICAL TRADES' UNION.—Head Office, Club Union Buildings, Clerkenwell Road, E.C. Electrical workers of Greenwich and District are invited to attend a meeting to be held on Friday, October 29th, at "Old Friends," Old Woolwich Road, East Greenwich. Chair at 8 p.m. 1760

ELECTROLIER ARTIST requires home work for evenings. Very moderate terms. Specimens of designing post free.—"DESIGNER," 41, Caversham Road, Kentish Town, N.W. 1754

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SMALL 3 H.P. Motor for Sale, very light, suitable for launch or motor car.—Apply 1,762, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1762

TENDERS Wanted for No. 2 Leclanché glass jars, delivered London, in quantities of 1 to 10,000.—1,782, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1782

TO MANUFACTURERS.—Advertiser, 12 years' electrical experience, leaving shortly for South Africa, is free to push sales of electrical manufactures, take up agency, or carry out any commission, reasonable terms,—1,773, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1773

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WANTED.—Electrical Fittings, Instruments, cheap for cash. —71, Iverson Road, Hampstead. 1790

WANTED, Electric Lamp Tops and Scrap Platinum.—EDEY AND CO., 29, Ludgate Hill, London. 1479

WANTED.—35 to 50 kw. combined compound engine and shunt dynamo, about 220 volts Willans or Belliss preferred. —Give full particulars to "ENGINEER," Electric Light Company, Nuneaton. 1742

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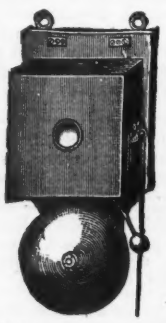

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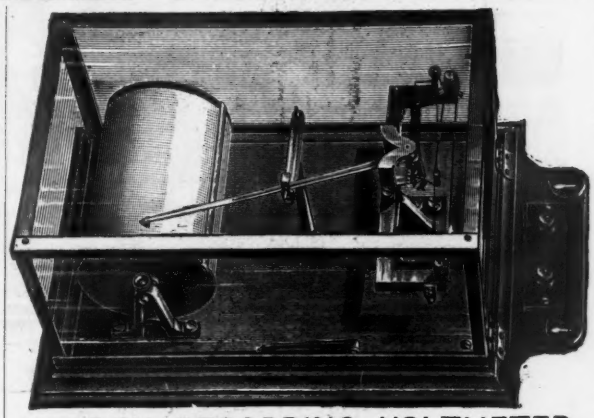

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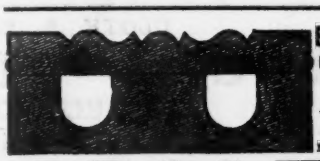

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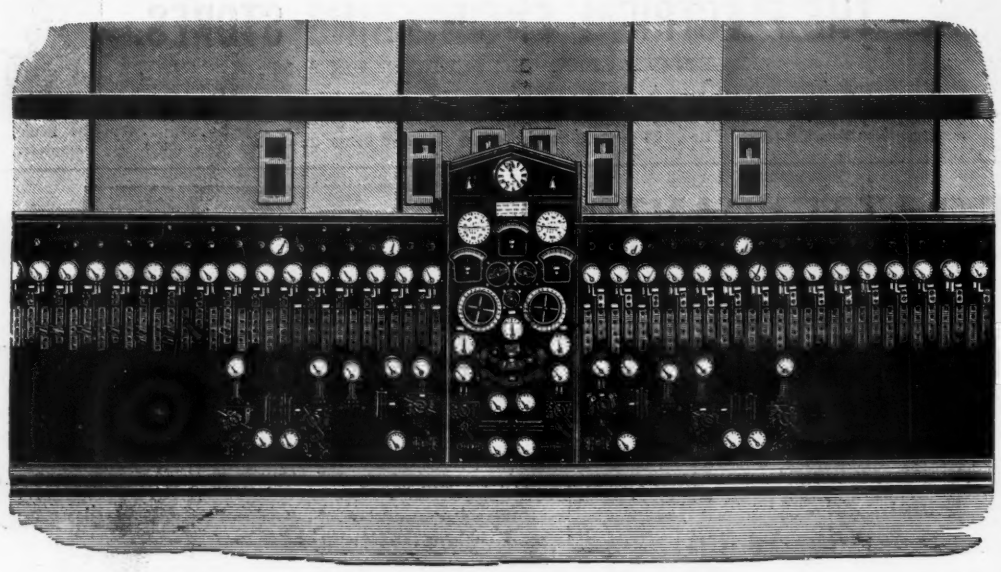

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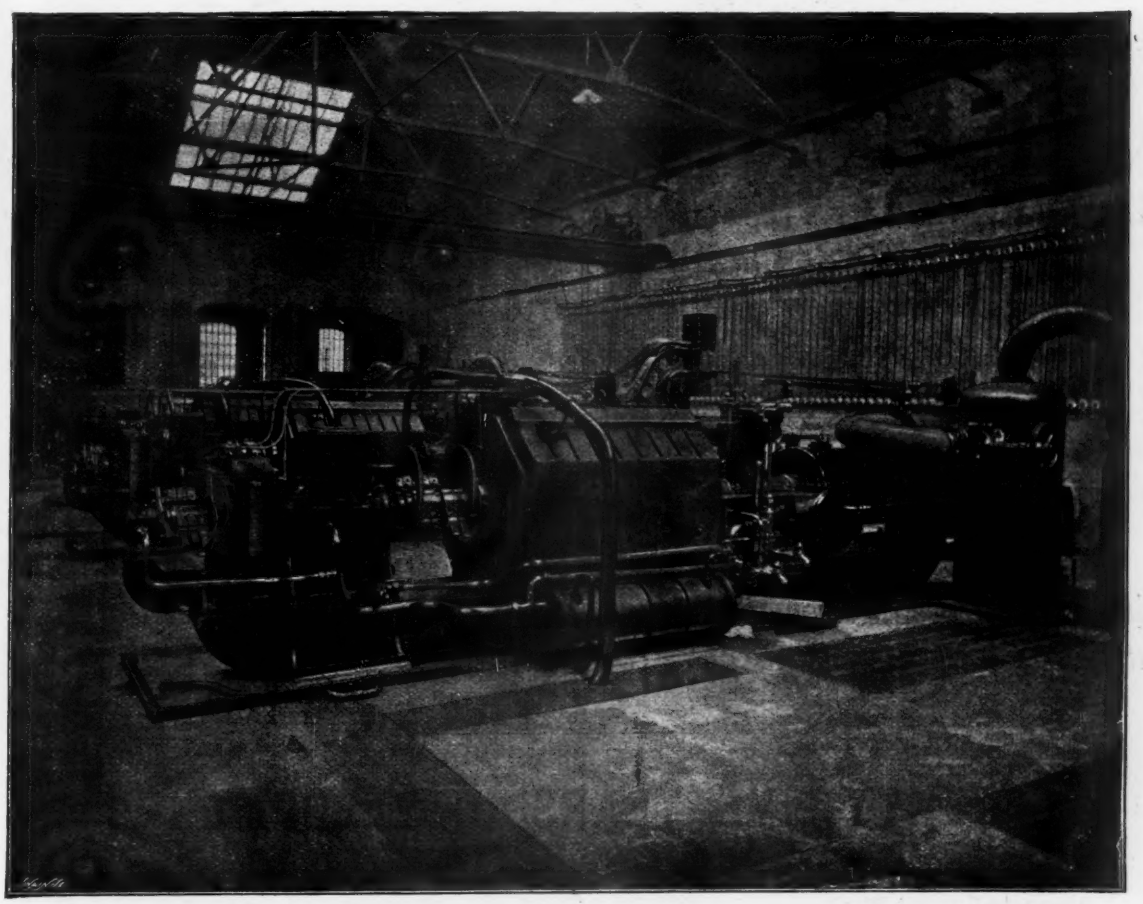

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The value and the interest which will attach to this special issue may be gathered from the subjoined list of subjects and writers, and others may yet be included.

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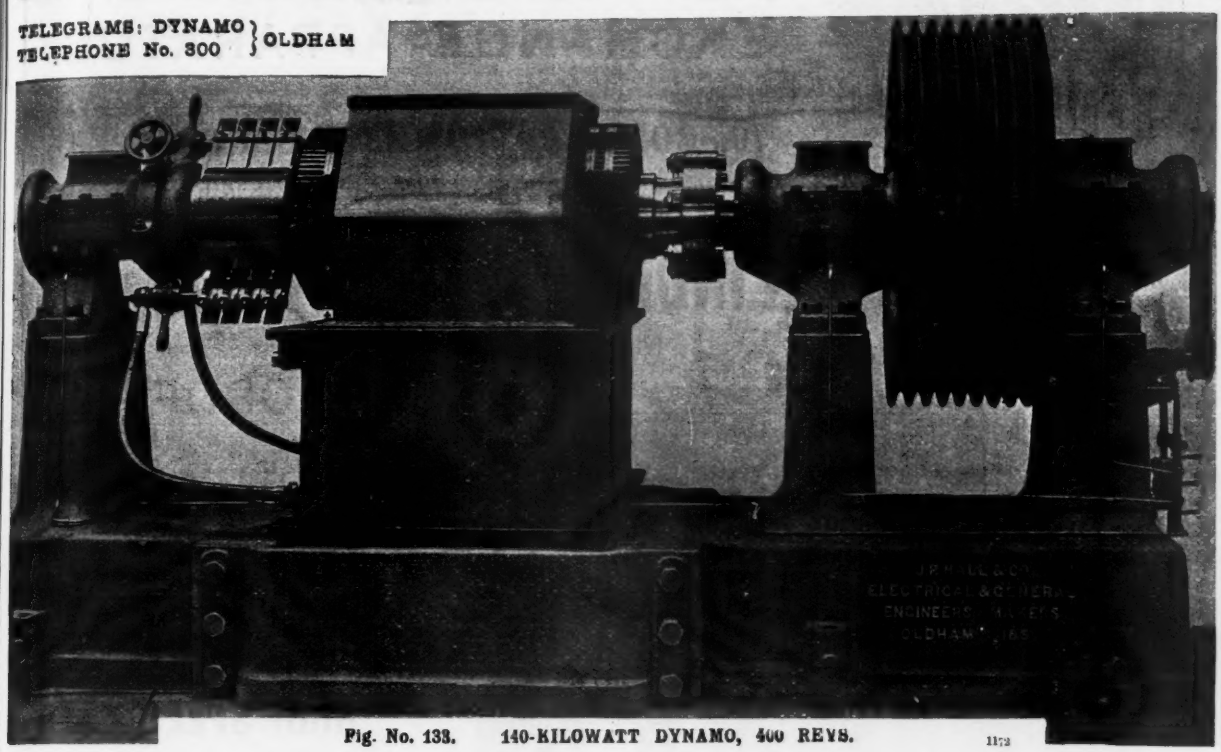

Fig. No. 133. 140-KILOWATT DYNAMO, 400 REVS. 1173

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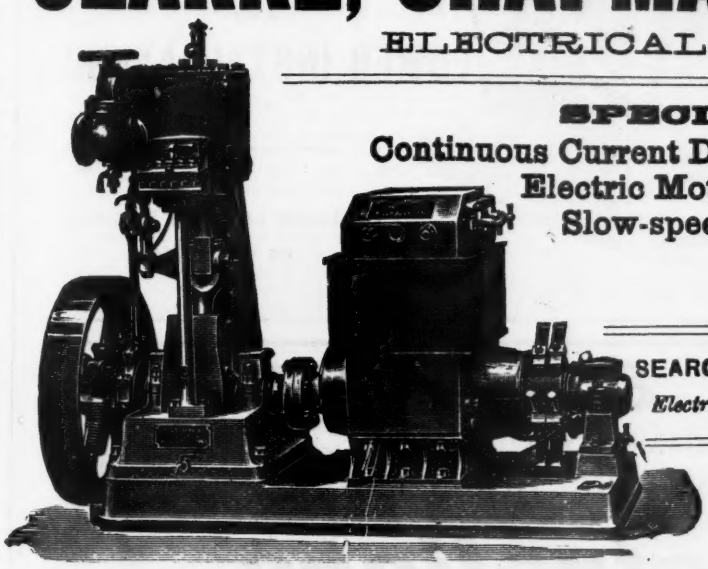

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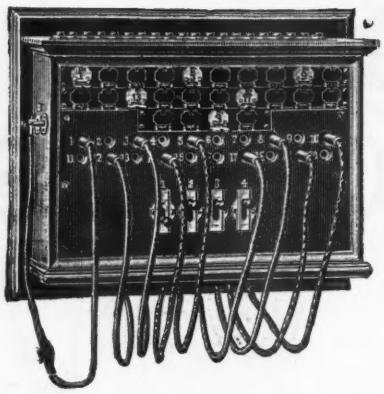

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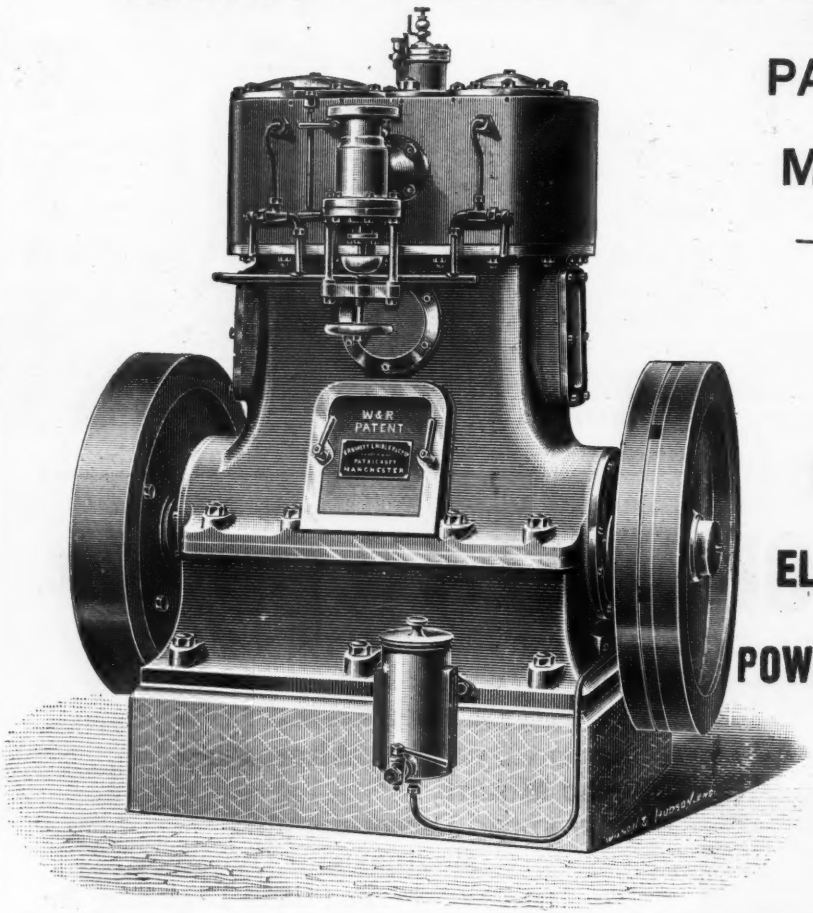

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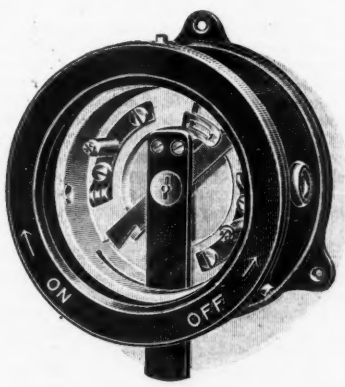
by the *Electrician* Printing and Publishing Company. The book is edited by Mr. C. E. S. Phillips. The same publishers will also issue at the end of October a new work by Messrs. Fisher & Darby, entitled, "The Students' Manual to Submarine Cable Testing."

High Tension Switch.—This switch consists of a cast-iron case of circular type, containing an inner porcelain chamber, on the inside surface of which all the parts carrying current are secured. The ebonite handle, which is brought through a slot in the cast-iron case and porcelain, operates the switch, and can be worked safely by the most inexperienced person without danger of shock, although working at pressures up to 10,000 volts. The switch may also very easily be worked at a distance either by a cord or bell crank, thus making it specially suitable for underground converter chambers. By means of a specially-arranged spring, it is quite impossible to have the switch making bad contact, which has been a great source of trouble in other forms of switch used by an inexperienced person, and probably left for weeks at a time without inspection. This switch, although single-poled, has a double break amounting to 4 inches, making it doubly secure against arcing. This break is effected by a spring, which is only put under full stress when the switch is being



opened; so that there is little or no liability of the spring taking a permanent set, and failing to effect a quick break on opening, as sometimes happens when the spring is under stress and allowed to remain closed for a long period. Even if the spring is broken, which is very unlikely, being of a novel design, the switch may still be operated. This switch may be fixed to any damp wall without fear of the insulation breaking down, even if the wall be running with water. Every precaution is taken against surface leakage, and the switch may be tested to three or four times its working pressure. The present switch is of small size, but will break circuits up to 30 kilowatts, at 2,500 volts, with ease. Larger sizes can be made if necessary. This switch is designed and patented by Mr. G. W. Partridge, of the London Electric Supply Company, and is the result of a great deal of experience on his part with different types of primary switches. Messrs. Elliott Brothers are making the switch for him under royalty.

Lazare Weiller & Co.—Mr. Fernand Espir, of 3, East India Avenue, E.C., who is the agent in this country for the above firm, informs us that the considerable extension of the works and the further developments which they are likely to receive, have made necessary an important alteration in the formation of the company, which was, on September 1st, at a general meeting of shareholders, formed into a "Société Anonyme," under the style of "Compagnie des Establissements Lazare Weiller." Mr. Lazare Weiller remains at the head of the firm as managing director.

Lists.—The Waltham Engineering Company have issued supplement No. 1 to their Art Metal Catalogue. This list gives a few special ornamental designs of switches and electroliers.

From Messrs. W. Scupham & Sons, timber merchants, of Mill Street, Leeds, we have received a small list of electric blocks of various sizes, shapes and patterns, also wood casings, &c., made by them.

Mr. A. J. Beaumont, A.I.E.E., of York, has issued a list of his projectors, the "Nouvelle" and "Eureka" automatic arc lamps, the "comme-il-faut" hand-feed slow motion arc lamp, and the "Jubilee" hand-feed arc lamp.

London Agents.—Messrs. Thomas Richardson & Sons, Limited, Liverpool, who are working in conjunction with Messrs. Brown, Boveri & Co., the well-known electrical power engineers of Baden, have appointed Messrs. Geipel & Lange, of 68, Victoria Street, Westminster, as their London representatives. Messrs. Richardson's installation at Hartlepool is creating great interest in industrial circles, and we understand the firm has booked a large number of orders for polyphase electric machinery.

Sunbeam Lamps.—The new and revised list of the Sunbeam Lamp Company, Limited, of Gateshead, contains several illustrations of the works, showing the various departments, and gives details and sketches of various kinds of incandescent lamps manufactured there. There are lamps of high candle-power up to 2,000, and two tables give the current required for these lamps of various powers in either the "high efficiency" or "longer duration" classes; lamps for high voltage, also conical "specials," fluted, tubular, and other shapes. The "Sunbeam" lamp-holders, X ray focus tubes, and other lines are included in the list.

ELECTRIC LIGHTING NOTES.

Bath.—The Town Council has declined to confirm the appointment of Mr. Collins as clerk of works (as appointed by Mr. Hammond), and Mr. Metzger, the city electrical engineer, has been appointed to do the duties. The Electric Lighting Committee is to consider "the advisability of making such arrangements as would allow the whole of the work being placed under the control of Mr. Metzger."

Brechin.—The Police Commissioners have decided to apply for a provisional order for electric lighting, to enable them to complete their agreement with Messrs. Edmundsons, Limited.

Brierfield.—The District Council has decided to adopt the Electric Lighting Act.

Buenos Aires.—From the *Review of the River Plate* we learn that the Primitiva Gas Company had in its electric light section 350 customers with 10,845 incandescent and 56 arc lamps, the average price being 24½ cents gold per kw. for lighting and 15 cents gold per kw. for power. There are three other gas companies supplying the city.

Colwyn Bay.—The District Council has decided to raise a £1,500 loan for an installation for electrically lighting the new promenade, which is at present without any light at all at night time.

Coseley.—On 15th inst. the District Council considered the advisability of applying for a provisional order. It was stated that an electric lighting scheme would cost £10,000 to £12,000 with an annual outlay of £1,000, and it was decided not to entertain the matter.

Dover.—The Town Council last week had a lengthy discussion regarding the inefficient electric lighting, it being stated by several speakers that the C.P. did not come up to the amount required by the contract. It was considered that photometric tests should be made and it was proposed to purchase a photometer for the purpose at a cost of £90, but the matter was ultimately left over for a fortnight for the surveyor to make further inquiries into what was done in other towns when this point arose.

Festiniog.—An application from an electric lighting company for permission to erect works for the purpose of generating electricity for lighting the town, has been rejected by the Council.

Glasgow.—The battery station which the Corporation Electricity Committee resolved some time ago to establish in Claremont Street for the West-End, has been equipped and brought into operation. In the equipment of the station, says the *Glasgow Evening News*, there are two sets of 60 Tudor secondary cells. These will all be fed from the principal station in Waterloo Street, and discharged to supply the demand for electric light all over the West-End of the city. There are sub-stations in Newton Street and at St. George's Cross. A battery station, somewhat similar to the one in Claremont Street, will now be proceeded with near the Cross.

During the vacation the Treasury have introduced an installation of electric light into the Court rooms, the Parliament Hall, and the passages and lobbies at the Court of Session.

Gloucester.—The City Council last week adopted the Electric Light Committee's recommendations respecting the electric lighting scheme.

Gosport.—The District Council has instructed the Drainage Committee to consider the advisability of lighting the town by electricity.

Grimsby.—The Public Lighting Committee have decided, before employing an electrical expert, to appoint a sub committee to get all the information necessary, and afterwards to employ an expert.

Hackney.—We understand that the Board of Trade has reported to the Vestry that it has no power to extend the time limited by Section 21 of the 1893 Electric Lighting Order, but that body offered to give the power of re-formation for a period of 12 months from August 12th.

Ipswich.—The Clerk to the Board of Guardians and the Clerk of Works at the new workhouse are to visit London to see the electric lighting of certain similar buildings, to guide the guardians as to whether to light their workhouse in the same way.

King's Norton.—The District Council will apply for a provisional order.

Kirkcaldy.—The Town Council has delayed the matter of electric lighting until after the elections in November.

Langley Park.—The roads in the Langley Park district are now lit up with the electric light, says a Newcastle paper, the current being supplied by the colliery company by arrangement with the local authority.

Leeds.—Before the end of next month, says the *Leeds Mercury*, it is probable that the two main thoroughfares of Leeds—Briggate and Boar Lane—will be lighted with electricity. For this purpose the Corporation some time ago ordered 40 electric lamps, each to be of the nominal illuminating power of 2,000 candles. These are to be placed on the top of the central poles and side brackets used in connection with the electric tramway, and the current required for the illuminating power is to be supplied from the generating station at Crown Point.

Lincoln.—A Local Government Board inquiry was held on 13th inst. into the Town Council's application for a £21,000 electric lighting loan.

London, E.C.—The City of London Electric Lighting Company has suggested that the Commission of Sewers should pay their bill, and that the question of liability for the inspector's expenses should be determined later. The solicitor introduced the matter at Tuesday's meeting when it was referred to the Streets Committee.

On the recommendation of the Streets Committee, the Commission has decided to light the City portion of Middlesex Street by electricity at a cost of £208 per annum.

Long Eaton.—A Sheffield paper says that the Council is to be asked to take into consideration the question of putting down an electric lighting plant for street and private lighting.

Llandudno.—The District Council on Friday last discussed the electric lighting and refuse destructor scheme and approved of the acceptance of the tender of Mr. R. L. Roberts for buildings at a cost of £5,000 odd. Mr. A. H. Preece recommended the acceptance of the following tenders:—

Section A.—Boiler, Babcock & Wilcox	£2,504	10	0
„ B.—Condenser and Pipework, Sunderland Forge Company	1,536	10	0
„ C.—Engines and dynamos, India-Rubber, Gutta-Percha, and Telegraph Works Company	3,235	0	0
„ D.—Switchboards, Messrs. White	695	0	0
„ E.—Battery, Pritchetts & Gold	856	0	0
„ F.—Overhead Crane, Sunderland Forge Company (subject)	75	0	0
„ G.—Mains, W. T. Henley's Telegraph Works Company..	5,123	0	0
„ H.—Arc Lamps and Posts, Crompton & Co.	1,229	18	0

Total £15,300, subject to some slight reductions. These acceptances were approved by the Council. There were 53 tenders sent in from different firms. Many firms tendered for several sections making altogether 80 tenders. A clerk of works is to be engaged at £3 3s.

Macclesfield.—At a meeting of the Gas Committee on September 13th, Mr. Reeves, of London, secretary to the Electric Supply Corporation, Limited, attended to advocate the putting down of plant for the supply of electricity in the town either by the company he represents, or preferably by the Town Council itself. The Committee replied that it could not see its way at present to recommending the Council to embark in such an undertaking, for which there is no evidence of a demand.

Maidenhead.—The Town Council has decided to apply for a provisional order, and has appointed an Electric Lighting Committee, which consists of all members of the Council who are not shareholders in the Gas Company.

Middlesbrough. — Last week the Council confirmed the appointment of Mr. R. Hammond as electrical engineer to supervise the construction of the electric lighting undertaking at 5 per cent. commission. The area of supply has been decided upon.

Montrose.—The Council on 15th inst. resolved to apply for a provisional order, which, we understand, is to be transferred to Messrs. Edmondson.

Paisley.—The Electric Lighting Committee have reported on the contracts for the new electric lighting station to be erected at Blackhall. They state that although the plant at present on order will be sufficient to light some 10,000 lamps, the buildings will provide accommodation for fully twice as much plant without extension. Various tenders for work connected with the new buildings have been accepted. The price to be charged for supply has been fixed at 7d. per unit for the first hour, and 3d. per unit after.

Port Adelaide.—The Mayor of Port Adelaide has signed a contract for the electric lighting of that municipality. The work will be carried out, says a Sydney exchange, under the direction of and from plans and specifications prepared by Mr. W. W. Crawford, consulting engineer, of Sydney. The plant will be of the latest and most modern type and be manufactured by Messrs. Johnson and Phillips.

Scarborough.—The electric lighting installation presented to the Scarborough Hospital and Infirmary by the Freemasons of the town, was inaugurated on 12th inst.

Skipton.—The Council has appointed a sub-committee to inquire into the desirability of the town being lighted by electricity under the control of the local authority. It is suggested that the Council's water supply at Eastby can be utilised.

Sculcoates.—The Board of Guardians has referred the question of lighting the workhouse by electricity to a sub-committee which may get professional advice if necessary.

Southport. — The Council is applying to the Local Government Board for a £21,000 loan to extend the electricity works to cope with the increasing demand.

Southsea.—A partial installation of the electric light on the Clarence Esplanade Pier has proved successful. The directors are now considering the desirability of electrically lighting the large pavilion.

Spain.—Last week, says the daily press, there was inaugurated in the city of Malaga another development of English capital in Spain, by the opening of an electricity supply works there, erected to the plans of Mr. Robert Hammond, of London, for a group of London capitalists. The works and plant were duly blessed by the Provincial of the Jesuits, Very Rev. Father Sensano, in the presence of Mr. Robert C. Wyatt, the chairman of the company. The plant is by Messrs. Fowler, of Leeds. The electric light is a boon in so hot a climate, and there are already 600 customers wired.

St. Pancras.—The Vestry has resolved to allow its fire policy with the Phœnix Fire Office to lapse and to insure the electric light undertaking with the Fine Art and General Insurance Company at a reduction of premium amounting to £12 15s. The total of this is £25,000. The Vestry transferred a £10,000 policy on the Regent's Park Station from the Phœnix to the Fine Art Company in June last.

Swansea.—Alderman Leeder has given notice to move that a resolution come to in July by the Council authorising negotiations with the Tramway Company, with the object of getting the triple scheme revived, be rescinded.

Theatre Lighting.—Two recently-built theatres are an exception to ordinary practice, they are both electrically lit throughout, and yet each receives the whole of the current required from the public supply. The larger of the two is the new theatre at Sheffield, Mr. W. G. R. Sprague being the architect, and Messrs. Owen Lucas and Pyke the consulting electricians. There are 435 16-C.P. lights in the back of the house, while 154 lights of 16-C.P. and 257 lights of 8-C.P. serve for that portion of the house devoted to the public, there is also a provision for 250 extra lights to be variously disposed as circumstances may require, the exterior of the theatre being illuminated with three arcs. Mr. Clarence Somes new theatre at Newport, Mon., is provided with 353 lights of 16-C.P., four lights of 8-C.P. and two "electric limes" in and behind the footlights, while the front of the house is lit by 15 lights of 32-C.P., 40 of 16-C.P., and 261 of 8-C.P., the same consultants being responsible for the architecture and the electrical specification as in the Sheffield house. It would be interesting to know what may have been the causes determining that these theatres should be served by the public supply, whereas so many houses are obliged to put in generating plant to obtain current at the very time that the shop load is going off the public mains, a time at which one would think there should be plenty of current available at a low price for so good and late a customer as a theatre must be.

Walsall.—The Electric Lighting Committee has reported that the total number of consumers supplied on September 30th, was 87. The committee have accepted the tender of Mr. W. Wistance for laying the foundations of the condensing plant for the sum of £35, and the tender of Mr. A. Lynex for fitting the transformer station in Park Street for the sum of £25. The engineer has been instructed to prepare a plan showing the position of the electric mains in the streets.

Willesden.—The District Council last week discussed the question of electric lighting for the district, and it was decided that Messrs. Pinkham & Adams should accompany the engineer to inspect various municipal electrical works.

Yeovil. — The Town Council will promote a bill in Parliament during the ensuing session for securing powers to supply gas and electricity.

York.—The Electric Lighting Committee state, in a report to be presented at a special meeting on the 25th inst., that a canvass of the compulsory area shows that the total number of units which the Corporation may rely upon being used annually, as soon as they could be supplied, amounted to 93,480. It had been ascertained that a demand of 100,000 units at 6d. per unit would ensure a surplus income over outgoings, and from information supplied by other towns the demand invariably exceeded the promises made at a canvass. The committee had come to the conclusion that no scheme would be satisfactory that did not include a destructor, and the utilisation of the heat to be obtained from burnt refuse. They had asked a number of firms to state definitely on what terms they were prepared to take over the electric lighting of the city, and were of opinion that none of the offers were such as they could recommend the Council to accept. The only alternative was for the Corporation to undertake the work themselves. They believe that if the Corporation undertake the work there is every prospect of the undertaking proving a commercial success, and of a satisfactory profit in reduction of the rates of the city being secured. The Committee, therefore, recommend the Council to accept the tenders as recommended by Prof. Kennedy in his report of January 7th last, and to instruct the Town Clerk to apply for leave to borrow the requisite amount—namely, £20,000.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Airdrie and Coatbridge.—The Joint Committee of Coatbridge and Airdrie Town Councils, which is considering the proposed tramways running through both burghs, has had before it an offer by the New General Traction Company for the laying of the tramway on the electric trolley overhead system. The company propose to undertake the work on a concession by the burghs of 15, 25, or 35 years. The company are to do the whole of the financing. On behalf of Coatbridge Committee, it was stated that the matter had not yet been properly before the Town Council, and that they would require to report to that body. It was accordingly arranged that the two committees consider the matter independently, and then have a joint meeting to prepare a report.

Bournemouth.—On Wednesday the Council had before it the electric tramway proposal, of which we wrote last week. There are three companies seeking to construct tramways throughout the town and suburbs, proposing also to connect the neighbouring

towns of Poole and Christchurch. The Council decided almost unanimously to inform the parties that the Council would not recognise any but an electric system, and that in all probability, if any scheme was adopted, the Corporation would carry out the work themselves.

Brighton and Rottingdean.—The directors of the seashore railway contemplate having a supply of electricity from the Brighton Corporation which will enable an hourly service to be regularly carried on, and the journey to Rottingdean to be accomplished in 25 minutes. Only three trips per day have been made to Rottingdean so far, and the receipts have averaged £100 per week. It is estimated that the future annual income will amount to £4,720, and the probable expenditure for working expenses, maintenance, payment of debenture interest, &c., is £2,320 thus leaving an estimated surplus of £2,400. Applications have just been invited for 800 6 per cent. preference shares (£10).

Broadstairs.—The Light Railway Commissioners have informed the Broadstairs District Council that they are prepared to recommend the application for the construction of the proposed overhead electric tramways.

Buenos Aires.—Mr. W. R. Cassels has applied to the Buenos Aires municipality for leave to construct and work an elevated electric tramline from Plaza Colon to Casa Amarilla, and from there to Calle Caseros and the Southern railway station. The current, according to the *Review of the River Plate*, would be supplied from the power house of the River Plate Electric Light and Traction Company in the Paseo Colon. The line would become the property of the municipality after 60 years. The petitioner offers to carry out the public lighting in the streets through which his line would pass. The work to be finished six months after the approval of the contract. The Intendente of Buenos Aires has forwarded to the City Council, a proposal made by Messrs. A. Parcus & Co. for the construction and working of a network of electric tramways in the city.

Cardiff.—The question of proceeding with the electric tramway scheme in the ensuing session cropped up at the Parliamentary Committee on Saturday. Alderman Carey assured the committee that the scheme had been pushed forward very vigorously, and he was certainly a little surprised last Monday to find that a delay of 12 months was even anticipated. The Town Clerk certainly had a great deal of Parliamentary work to get through with the borough boundaries scheme and so on, but he thought the electric tramway scheme was the first in the field. The Town Clerk said that there was a very strong feeling in the council that the scheme should go on, but with him it resolved itself into a question of policy, for he took it that one of the inducements to outside districts to agree to the borough extension scheme would be the promise to carry the electric tramways into the district. After a discussion it was resolved that the Bill for the next session should include only that portion of the electric tramways that related to districts within the borough.

Chatham.—The Chatham Town Council, Rochester Town Council, and the Gillingham District Council have decided to support the scheme (subject to all exceptions) of Mr. Fraser, the engineer for the promoters, of the project for constructing a series of electrical tramways for uniting the several urban districts of Chatham, Rochester, and Gillingham. The Councils consider that such tramways, which would run by overhead wires, would be a benefit to the neighbourhood.

Clontarf.—On Saturday morning a trial trip was made by the contractors over the electrically equipped section of the Clontarf tramways. The run from the depôt to Annesley Bridge—the city terminus of the electrical installation—and back occupied some 20 minutes, representing a speed of about 8 miles an hour, the distance being 2 35 miles. It was performed without a hitch, and Mr. Jacob, who has represented the contractors, the British Thomson-Houston Company, London, in the erection of the electrical plant, and who drove the car throughout the journey, expressed himself highly satisfied with it from an engineering point of view. The official inspection takes place this week.

Dublin.—The Judicial Committee of the Privy Council sitting at Dublin on 12th inst, granted the application of the Dublin Southern District Tramways Company who sought powers to reconstruct the tramways passing through George Street, Kingstown, so as to change the double line into a single line with passing places. It is stated that the double line has caused a great deal of inconvenience to traffic in George Street.

Dover.—The receipts on this electric tramway continue satisfactory. For the week ending Saturday, October 9th, 29,781 persons used the cars, and £124 1s. 9d. was taken. The daily average was 4,963 persons and £20 13s. 7d. There have been quite a number of small accidents at Dover since the trams started running. On Monday last week as one of the cars was passing the junction at the bottom of Worthington Street the "arm" dragged, and that and the pillar supporting it on the top of the car, as well as the side rails, and one or two of the seats were torn away, and fell on to the road. The damaged car, the top of which was quite wrecked, was eventually taken in tow by another car to the shed at Buckland.

La Plata.—Messrs. W. R. Cassels and John MacGee are stated to have made application to the La Plata Government for a concession for an electric railway from La Plata to the Federal Capital.

Light Railways for Crewe.—The Light Railways Commissioners, who held an inquiry some time ago at Crewe to consider an application for a light railway scheme, have prepared an order embodying their requirements. Their scheme differs somewhat from the original proposals in the direction of better safeguarding the interests of the Corporation. The scheme has been forwarded to the various parties for observations. It is anticipated that it will go forward.

Manchester v. London.—Writing recently respecting the unanimous recommendation of the Manchester deputation in favour of the overhead electric trolley system, *Daily Tenders and Contracts* says:—"It is noteworthy—and the London County Council should bear this in mind—that this recommendation is made unanimously by the Special Committee on Tramways and by the Electricity Committee, and that the trolley principle is submitted as being the best adapted to the requirements of a great commercial city like Manchester. If suitable for Cottonopolis, why not for the Metropolis? It is a pity the Highways Committee of the County Council withdrew its proposal made some time ago to inspect the Bristol electric tramways. If this had been done we might have been nearer the attainment of electric tramways for London, even though they be restricted to the suburbs at the outset. Nevertheless, time, the great changer of ideas and customs, will probably bring about this desirable consummation to the benefit of all."

Newcastle.—A Ratepayers' Tramway League has been formed here to oppose the leasing of the tramways to any individual or company.

Southport.—At the last council meeting it was resolved on the motion of Mr. W. Hulme to refer the report of the Tramway Sub-committee to the Tramways Committee to be elected on November 9th. The report recommends the laying down of electric tramways in the parts of the borough not yet having a tramway service.

St. Helens.—The Tramways Committee recommended the adoption of electricity as a motive power for the St. Helens and District tramways. The committee visited West Hartlepool, Coventry, Leeds, &c., and the Council has now adopted their recommendation, and appointed Dr. John Hopkinson as adviser and consulting engineer in connection with the scheme.

Yarmouth.—In reply to a request from the A.B.C. Company for a supply of current for crane motors at their wharf, the Council offered to provide the apparatus at a cost not exceeding £250, subject to the company guaranteeing an annual payment of £30 for six years.

TELEGRAPH AND TELEPHONE NOTES.

City Commissioners and Telephone Matters.—At Tuesday's meeting of the Commission of Sewers, a communication was read from the Town Clerk of Glasgow, thanking the City for the valuable assistance they had afforded to the Corporation by appointing Mr. Morton to give evidence at the recent telephone inquiry at Glasgow. Mr. Morton, in his report, said that it was stated at the inquiry that the London County Council had given consent to the placing of telephone wires underground in London. He did not know that any such consent had been given, neither could such consent over-ride the powers of the Commission in the City, or the powers of the vestries and district boards in the rest of the metropolitan districts; and he also informed the Commission, but it was unfortunate that the consent, apparently given by the London County Council (without any conditions as to better service or reduced price) to the placing of telephone wires in the subways under the control of the Council, should have been so made use of, against the best interests of the metropolis. A letter was read from the parish of St. James, Westminster, intimating that it had adopted the action of the Commission, and had declined to accede to the applications of the National Telephone Company in respect to the laying of underground wires, as the company was not prepared to make any proposals for the benefit of the parishioners. On the motion of Mr. Morton, the vestry was thanked for its action. The Clerk said the Postmaster-General had asked for permission to take up the pathway in a portion of Holborn for the purpose of laying telegraph wire pipes from opposite 19, Holborn, and from the north-west corner of Ludgate Circus, opposite Messrs. Cook's offices, into 109, Fleet Street. The Clerk said he had given permission providing that the wires were not to be used for the purposes of the National Telephone Company.

Delays in the Cable Service to Australia.—In last week's issue we published the correspondence addressed to the Secretary of the London Chamber of Commerce by the Postmaster-General of South Australia. The frequent interruptions and delays to the telegraph communication with Australia and New Zealand have hitherto been borne in silence, and with great toleration, by the telegraphing public. It is gratifying to find that at length the matter has been taken up in an influential quarter, and it is to be hoped that some improvement may be the result. Mr. C. Todd, the Postmaster-General of South Australia, describes the delays complained of: 1st, to heavy business; 2nd, to difficult circuit on the Port Darwin line from weather conditions; and 3rd, largely to the introduction of the universal telegraph code at that time. To deal with these points *seriatim*, first, if the delays are due to heavy business, we may conclude that the existing lines are insufficient for the purpose for which they are designed, and therefore should have their carrying power increased. An attempt was made in this direction some years ago by extending a system of aerial lines along the coast of Western

Australia, to join a submarine cable which had just been laid from Java to Roebuck Bay. This cable, it may be noted in passing, was laid owing to the frequent interruptions of the two cables which already united Java with Australia (at Port Darwin). We have it, however, on the authority of the Hon. Mr. Thos. Playford, the Agent-General of South Australia, that the new Western Australian line was comparatively inefficient, owing to its liability to interruption by thunderstorms and atmospheric causes, and that the South Australian (Port Darwin) line carried the whole of the messages. From this it is clear that the Western Australia line cannot be accepted as an addition to the carrying power of the original line, and the Westralian landline being inefficient, it follows that the submarine cable which it joins at Roebuck Bay becomes practically useless. Second, as to the difficult circuit on the Port Darwin line, owing to weather conditions. It would appear from this that the South Australian line is subject, although it may be in a lesser degree, to the same weakness as that which, according to Mr. Playford, renders the Westralian line of such little value. There are, however, other difficulties to be encountered in maintaining the South Australian line. To quote from the Australian press, "the duty is one prolonged struggle against the forces of destruction, which come in many forms, from the silent work of the white ant, to the brawling force of a sudden flood flowing miles in breadth through what a day or two before was a waterless desert." We even learn that in making repairs "the reliance for getting the work done appears to be upon the good swimmers on either side who are engaged upon the task." This says much for the resource and energy of those engaged in keeping the line in good condition, and who doubtless do their best to prevent the delays complained of. Third, that the delay is due largely to the introduction of the universal telegraph code at that time. We do not know the dates of the specific delays referred to in the letter of Mr. Kenric B. Murray, dated July 22nd, as this letter has not been made public; but it is interesting to note that on July 17th the South Australian line was interrupted, and that cable traffic was being sent by the Westralian line. It may also be mentioned that the Universal telegraph code was introduced on July 1st, and therefore cannot be looked on as excusing any delays prior to that date. The Postmaster-General of South Australia states that "so far as the lines in this colony are concerned, delays have very rarely occurred, and the recent experience was quite unexceptional" (*sic*). Presumably "exceptional" is the word intended, but in view of the fact that the lines referred to were interrupted (as far as can be gleaned from the Australian press) on at least six occasions last year, for four days on one of these occasions, it is perhaps as well that the word "unexceptional" should stand. During this year there have also been several complaints recorded; on one of these occasions the line was interrupted for three or four days, and on the 6th ult. the Postmaster-General of New South Wales received the following advice from the Postmaster at Adelaide:—"Port Darwin line unworkable. Very slight hope of getting any business through to-night." Mr. Todd further attributes occasional delays to "defective circuit on one or other section of the long line connecting Australia and England." Space does not permit our going into this part of the matter at length; it may be sufficient to say that our present means of telegraphing to Australia and New Zealand are not at all satisfactory. This has been proven over and over again at the several Colonial Conferences which have been held at various periods for a number of years back, and it seems that until a radical change is made, and an entirely new telegraph system constructed—preferably *viâ* Canada and the Pacific Ocean—these delays may be looked on as chronic, and must, we suppose, be borne with patience.

Post Office Revenue.—The *Times* says that the Chancellor of the Exchequer, in his reply to the resolutions of the Association of Chambers of Commerce, to the effect that the Post Office was looked upon too much as a revenue-earning Department, says:—"While he hopes that full attention will always be given by the Post Office, as he believes has been the case in the past, to the reasonable requirements of the important interests which your association represents, he is not at all prepared to admit that the postal telegraphic or telephonic services, some of which benefit comparatively small portions of the public, should be carried on without profit to the general taxpayers, and that he is surprised such a complaint should be made in a year in which a considerable part of the Postal revenue has been devoted to cheapening and extending the facilities already given."

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1893 ...	...
West Indies—		
St. Croix-Trinidad ...	Nov. 30th, 1896 ...	...
Cayenne-Pinheiro (Brazil)	Sept. 29th, 1897 ...	...
Amazon Company's cable—		
Parintins-Itacatiara ...	May 5th, 1896 ...	...
Obidos-Parintins ...	Dec. 7th, 1896 ...	...
Hong-Kong-Macao	Sept. 28th, 1897 ...	...
Otranto-Vallona	Oct. 11th, 1897 ...	...
Mozambique-Lourenzo Marquez	Oct. 18th, 1897 ...	...
Landlines.		
Trans-Continental line beyond Masol	March 12th, 1896 ...	...
Carthagena - Barranquilla ...	July 4th, 1896 ...	...
Siberian landlines—		
Khabarowka - Vladivostock (all lines)	Oct. 5th, 1897 ...	Oct. 16th, 1897.
Saigon-Bangkok	Oct. 15th, 1897 ...	Oct. 17th, 1897.

The Telephone in London.—A daily press correspondent gives what he considers one important reason why only one in 600 of London householders use the telephone. He says that early in January he wrote to the National Telephone Company, requesting them to connect his house with their system as early as practicable. "Some days after a representative of the company called upon me, and desired me to sign a formal agreement for five years, which I immediately did. But notwithstanding more than nine months have elapsed since I signed the agreement, I am still as far from being 'on' as I was before writing. It is true I have had one or two desultory visits from another employé, when he happens to be in my neighbourhood, who calls and assures me that I am not forgotten."

The Telegraph to Berber.—The telegraph has been completed to Berber in connection with the Nile campaign, but on 17th inst. it was out of order, owing to a recent storm.

CONTRACTS OPEN AND CLOSED.

OPEN.

Burnley.—November 17th. The Corporation invites tenders for the supply and delivery of lead-sheathed, armoured, underground cables. Borough Electrical Engineer, Mr. W. R. Wright. See our "Official Notices" this week.

France.—November 3rd. Tenders are being invited by the 1900 Exhibition Authorities in Paris for a complete installation of electric lighting in the Exhibition Administration Offices at the corner of the Avenue Rapp and the Quai d'Orsay. Particulars from, and tenders to, the Secretariat Général de l'Exposition Universelle de 1900, 26, Avenue de la Bourdonnais, Paris.

France.—October 23rd. The Prefectural Authorities of the Seine, in Paris, are inviting tenders until the 23rd inst., for an installation of electric lighting in the new barracks at present being erected in the Rue Jean Jacques Rousseau. Tenders to M. le Prefet de la Seine, Tribunal de Commercé, Paris.

Harrogate.—October 25th. The Corporation want tenders for the supply and erection of plant at the electricity works, including Lancashire boiler, vertical engine, alternator, exciter, &c. Borough electrical engineer, Mr. G. Wilkinson. See our "Official Notices" October 8th.

Hull.—November 5th. The Corporation invite tenders for the electrical equipment of their tramways, to the extent of about 9 miles double track and ½ mile single track. The contract will not be divided and will include engines and generators, switchboards, feeders, poles, brackets, trolley wire, rail bonding and all accessories, also the first instalment of cars (15 motor cars and 5 trailers). City engineer, Mr. A. E. White. City electrical engineer, Mr. A. S. Barnard. See our "Official Notices" September 17th.

London.—October 25th. From our "Official Notices" October 8th, particulars may be obtained of various stores for which the Great Western Railway Company are inviting tenders. Some of the items are for telegraphic and electrical sundries.

London.—October 25th. The Postal Authorities are inviting tenders for the supply of red fir telegraph poles, and also for creosoting the poles with 10 or 12 pounds of creosote to the cubic foot as required. Particulars, &c., from Mr. C. E. Stuart, Controller of Stores, G.P.O., London.

Queensland (Aus.).—November 15th. The Municipal Council of Ipswich, Queensland, is inviting tenders for the supply and erection of the following electric lighting plant, &c.:—Tubular boilers, pipes, pumps and heaters, alternators and exciters, switchboard, high and low tension mains, junction boxes, transformers, &c. Specifications, and all particulars as to conditions, &c., may be obtained from Messrs. Gordon & Gotch, St. Bride Street, Ludgate Circus, London, E.C., and tenders have to be forwarded to the Town Clerk (Mr. Albion Hayne), Council Chambers, Ipswich, Queensland. See "Official Notices" September 17th.

Roumania.—November 15th. Tenders are being invited by the Municipal Authorities of Ploesti, for the concession for the establishment and working of an electricity generating station in the town, during a period of 40 years for private and public lighting and also for power transmission purposes.

Russia.—November 1st. The Municipal Authorities of Novorossisk, South Russia, are inviting tenders for the concession for the construction and working of an electric tramway and for the electric lighting of the town.

Salford.—October 22nd. The Corporation is inviting tenders until to-day for the supply of high tension service cable and alternating current transformers. Borough Electrical Engineer, Mr. Turner, Wallness Road, Broughton.

Shoreditch.—November 2nd. The Vestry invites tenders for the supply and erection of additional engines and high tension continuous current generators, and an extension of the existing switchboard. See our "Official Notices" last week for particulars.

Spain.—October 25th. Tenders are being invited until the 25th inst. by the Municipal Authorities of Guadix (Granada province), for the concession for the electric lighting of the public streets of the town. Tenders to El Secretario del Ayuntamiento de Guadix (Granada).

Spain.—October 29th. The Municipal Authorities of Santona (province of Santander) are inviting tenders until the 29th inst. for the concession for the electric lighting of the public streets of the town. Tenders to El Secretario del Ayuntamiento de Santona (Santander).

Spain.—November 3rd. Tenders are being invited by the Municipal Authorities of Aznaga (province of Badajoz), for the concession for the electric lighting of the public streets of the town during a period of 25 years. Tenders to be sent to El Secretario del Ayuntamiento de Aznaga (Badajoz).

St. Pancras.—November 2nd. The Vestry want tenders for the supply and fixing of additional plant at the Regent's Park electricity works, comprising dynamos, engines and switchboards. See our "Official Notices" last week.

Victoria.—November 10th. The Agent-General for Victoria is inviting tenders for the supply of electric light cables and fittings, for the Railway Department of the Colony. Specifications, &c., obtained at the Offices of the Agent-General.

CLOSED.

Paisley.—We learn from Mr. Francis Teague, the engineer, that at the Town Council meeting on 12th inst., the following tenders for the building of the electricity works were accepted:—

	£	s.	d.
Excavator, brick and mason work; George Primrose..	7,888	18	5
Iron and steel work; Hanna, Donald & Wilson.. ..	541	9	10
Carpenter and joiner work; G. & T. Houston	1,156	13	4
Slater work; James Jeffrey & Co.	320	17	8
Plumber work; William Allison	360	10	6½
Plaster work; Alexander Maxwell	332	5	5
Glazier work; G. G. Kirk	247	7	0

Messrs. Hanna, Donald & Wilson's tenders for crane gantry at £145, and feed tank at £77 were also accepted. The price to be charged for current was fixed at 7d. and 3d. per B.O.T. unit on the Brighton system. Wright's Rebate Indicator will be used, the 7d. rate to apply the first hour daily at maximum demand.

FORTHCOMING EVENTS.

1897.

Friday, October 22nd.—Coventry Electric Tramways Company, Limited. Adjourned ordinary meeting at Bank Buildings, E.C.

Friday, October 22nd, at 8 p.m.—Institution of Junior Engineers. Annual meeting for the election of officers, &c., and to receive report of the Council, Westminster Palace Hotel.

Saturday, October 23rd, at 3 p.m.—Institution of Junior Engineers visit to the Queen's Road Station of the Central London Railway works.

Monday, October 25th.—Last day for receipt of tenders for electrical plant for Harrogate.

Monday, October 25th.—Last day for receipt of tenders for Great Western Railway Stores.

Monday, October 25th.—The York Corporation considers the recommendations of the Electric Light Committee in favour of municipal lighting.

Tuesday, October 26th.—Direct United States Cable Company. Interim dividend payable.

Wednesday, October 27th, at 12 o'clock noon.—Brazilian Submarine Telegraph Company, Limited. Forty-eighth ordinary general meeting, Winchester House, E.C.

Wednesday, October 27th.—Eastern Extension Telegraph Company. Half-yearly meeting at Winchester House, E.C.

Thursday, October 28th.—Finsbury Technical College. Prof. S. P. Thompson's third lecture on "Recent Developments in Electro-Chemistry."

Thursday, October 28th.—Brazilian Submarine Telegraph Company. Dividend and bonus payable.

Friday, October 29th.—Physical Society. Opening meeting for the session.

Friday, October 29th, at 8 p.m.—Electro-Harmonic Society Smoking Concert at St. James's Hall Restaurant (Banquet Room), Regent Street, W.

Monday, November 1st.—Indo-European Telegraph Company. Interim dividend payable.

Monday, November 1st.—Callender's Cable and Construction Company. Interim dividend payable.

Wednesday, November 3rd.—Institution of Mechanical Engineers' ordinary general meeting at 25, Great George Street, Westminster, for reading and discussion of papers as follows:—"Experiment upon Propeller Fans, and upon the Electric Motor driving them," by Mr. William George Walker, of London. Adjourned discussion and supplementary paper. "Diagram Accounts for Engineering Work," by Mr. John Jameson, of Newcastle-on-Tyne.

Thursday, November 4th.—Institution of Mechanical Engineers' ordinary general meeting at 25, Great George Street, Westminster. Paper on "Mechanical Features of Electric Traction," by Mr. Philip Dawson, of London.

Tuesday, November 9th.—Last day for receipt of applications for appointment of electrical engineer to the Glasgow Corporation.

NOTES.

Personal.—Mr. W. G. Bond has resigned the editorship of the *Electrician*. Mr. Bond joined the staff of our contemporary in April, 1888, and became editor-in-chief on Mr. Trotter's retirement in 1895. We cordially wish Mr. Bond success in whatever direction he now directs his energies.

On Tuesday afternoon the freedom of the city of Hartlepool was presented to Alderman Sir Thomas Richardson, M.P., in honour of the knighthood recently conferred upon him by Her Majesty.

Fast-Speed Telegraphing.—The following is from *Pearson's Weekly*:—"Telegraphing at the speed of 4,000 words a minute is something calculated to take one's breath away, especially when we reflect that a man does not ordinarily speak more than 150 words in that time, and indeed his average is considerably less, especially when he is at work, and is thinking while he is speaking. This speed, however, is achieved by means of a machine called the synchronograph, which has been tested over a line running to a length of 860 miles, and embracing in circuit London, Edinburgh, Glasgow, Newcastle, York, Leeds, and other places. It need hardly be said that human hands are not employed in this apparatus, and it depends on machinery. What the rate of speed means may perhaps be gauged by the fact that it would be possible to telegraph the whole of this number of *P.W.*, including the covers, from one end of the country to the other in about a quarter of an hour." A more misleading statement than the foregoing cannot well be imagined. It would lead one to suppose that a speed of 4,000 words a minute was obtained over an 860 miles circuit, which we have no hesitation in saying is, with our present knowledge, an absolute impossibility; 4,000 words per minute on practically short circuit might be obtainable, and the apparatus might have worked over the circuit described, but certainly not at anything like full speed. It is a pity that *P.W.* does not engage a competent scientist to revise its pseudo-scientific matter.

Yorkshire College Engineering Society.—The syllabus for the approaching session contains the following arrangements:—

Monday, December 13th, 1897.—"The Daimler Motor, and its Application to Auto-Cars" (illustrated), by J. Sidney Critchley (Daimler Motor Company, Limited).

Monday, January 31st, 1898.—"Electrical Engineers' Specifications," by J. A. McLaren.

Monday, February 14th, 1898.—"The Steam Turbine Engine, and its Applications," by John D. Bailie (C. A. Parsons & Co., Newcastle).

Monday, February 28th, 1898.—"Results of Experiments made in the Engineering Laboratories of the Yorkshire College," by the Students.

Monday, March 14th, 1898.—"Leeds City Electrical Tramways," by E. Talbot, Assoc.M.Inst.C.E. (Westminster).

Monday, March 21st, 1898.—Annual General Meeting.

Railway Signalling.—According to an Indian exchange, the electric block system is shortly to be introduced at the principal stations on the East Indian Railway.

The Storage Battery in America.—We learn from a recent editorial in the *Electrical Engineer*, of New York, that the American daily Press is learning to treat electrical matters in a "quite intelligent manner." May the day not be far distant when the same can be said of the newspaper Press of this country. As, however, we are considered to do better in our early days of study by making mistakes, the correction of which teaches the truth, so it seems that the American Press, in going through the learning stages, commits errors, which our electrical contemporary corrects in the following manner in an article on "The Trials of the Storage Battery":—"The storage battery has gone through so many trials and tribulations in the past, that those interested in its promotion have become callous to the criticisms one still hears now and then. These aspersions usually emanate from those who are not fully informed on the present state of the art, and hence carry no weight in themselves, but they are nevertheless apt to influence the judgment of the general public, and to that extent may do harm to an important branch of electrical industry. The most recent example of such loose and unwarranted statements regarding the storage battery is contained in an article recently appearing in the New York *Commercial Advertiser*. The article states that Mr. John Jacob Astor and Dr. Seward Webb had decided to abandon the use of the Samuels storage battery in their private yachts and cars, and this, according to our contemporary, 'marks another significant failure in this favourite method of electrical propulsion.' We refrain from rehearsing the painful details of this failure, as recited by the *Commercial Advertiser*, but its conclusions are so obviously unjust, that it seems worth while to point out one or two facts of which our contemporary may not be aware. It is probably true that the cells mentioned were abandoned, but that proves absolutely nothing as to the applicability of storage batteries to electrical boat propulsion or train lighting. It only proves that the Samuels battery was unsuited to its purpose. As a matter of fact Mr. Astor, so far from having lost confidence in storage batteries, has replaced the worthless cells by others of tried efficiency. So far as storage batteries on electric launches is concerned, the electric fleet at Chicago, in 1893, settled that question once for all, and one would have supposed that their wonderful performance there was sufficiently well known to have made our contemporary hesitate before committing itself to so sweeping a statement. Since then the Atlanta Exposition, and scores of private electric launches all over the country, have only gone to strengthen the hold of this method of marine propulsion on the public. Within the week, indeed, the Czar of Russia, after investigation by his naval experts, has ordered an electric launch from America. As to the storage battery in railway work, the recent excellent showing made by the battery in Hanover and Dresden, and in Paris, and lately in Chicago, are sufficient evidence of its adaptability to railway purposes. And as for stationary work, the merest tyro in electrical matters knows their acknowledged value in almost every situation. If our contemporary had only taken the trouble to go a stone's throw from its office, it might have seen a most excellent exemplification of what the modern storage battery can do, in the Bowling Green Building. Indeed, it is quite probable that our contemporary's office at certain times is lighted by current obtained from that very battery."

Institution of Mechanical Engineers.—An ordinary general meeting of this Institution will be held on Wednesday and Thursday evenings, November 3rd and 4th, at 25, Great George Street, Westminster. The following papers will be read and discussed as far as time permits:—"Experiments upon Propeller Ventilating Fans, and upon the Electric Motor Driving Them," by Mr. Wm. George Walker, London (adjourned discussion and supplementary paper). "Diagram Accounts for Engineering Work," by Mr. John Jameson. "Mechanical Features of Electric Traction," by Mr. Philip Dawson.

Coast Communication.—The fifth, and final, report of the Royal Commission appointed to inquire into the question of electrical communication between lightships and lighthouses and the shore has been issued. We shall deal with this next week.

The Leeds Tramway Mishap.—A correspondent writes as follows:—"The Leeds city electric trams appear to have been recently undergoing a regular chapter of accidents. I give herewith a few of the more important. Soon after they commenced running some of the trolley poles developed short circuits, and the fuses to earth had to be taken out, with the result that it is sometimes possible to get a smart shock by touching the trolley pedestal. Three out of the 10 cars are now lying disabled for this and other causes. Several short stoppages of traffic have been due to the snapping of the casting which carries the trolley wheel, and in one case this wheel fell and injured a woman so seriously, that she had to be taken to the infirmary. Last week a man was knocked down on the Kirkstall Road section, and instead of the life guard shoving him to one side, it lifted sufficiently for his legs to pass under, with the result that he died almost immediately. On Thursday last week the Sheepscar feeder developed a short, due, it is said, to the insulation being pierced by a pavior's pick, and the water getting in. Several hours elapsed before the fault was located, traffic being resumed by cutting the feeder out altogether. Last Saturday some of the trailers were put on the line, and proved a great convenience; but about 12 o'clock mid-day on Sunday the spindle of the high pressure valve of No. 1 engine broke down. In about 20 minutes the other engine was warmed up and set going, and it ran on until 2 o'clock in the afternoon, when its high pressure valve spindle also broke in exactly the same place. Even then the accumulators (although they are just completing the forming process) might have been used for bringing the cars home; but no! the keys to the accumulator sub-station could not be found, and a steam locomotive had to come to the rescue. The service was resumed on Monday afternoon. The sight of half-a-dozen cars, horse, steam and electric, standing in a line in the main streets of the city is becoming so common, that it has almost ceased to interest the man in the street."

The only official explanation we can obtain is that the accident was caused "through the accidental breaking of the valve spindle on the high pressure cylinder, which was repaired in 24 hours."

Advantages of Transfer of Powers.—The South London Electric Supply Corporation, having taken over the Lambeth Vestry provisional order, does not receive so much of the unnecessary attention from the London County Council which is inflicted upon other companies. This will be obvious from the following intimation given by the Highways Committee at Tuesday's meeting of the County Council:—"A notice has been received from Messrs. Kincaid, Waller and Manville, on behalf of the South London Electric Supply Corporation, of intention to lay high and low tension mains on both sides of parts of Tulse Hill, Upper Tulse Hill, Trinity Road, and Norwood Road. The order was originally granted to the vestry, and subsequently transferred by agreement to the company, and contains no provisions enabling the Council to approve or disapprove the works."

Application for Extension of Patent.—In last Tuesday's *London Gazette* is a notice to the effect that the Hon. C. A. Parsons intends presenting a petition to Her Majesty, praying that new letters patent may be granted or an extension of life for patent No. 6,735 of April 23rd, 1884, for "improvements in rotary motors actuated by elastic fluid pressure, and applicable also as pumps." The application will be heard by the Judicial Committee of the Privy Council on November 26th, or such subsequent day as they shall appoint.

Brussels Exhibition.—We learn that Messrs. Elliott Bros. exhibit in the International Exhibition of Brussels has been awarded second grand prize. They exhibited there various standard types of resistance boxes, their new recording instruments, ammeters and voltmeters, standard potentiometer, and some sets of high-speed telegraph apparatus. In the science section Messrs. Elliott had special cases containing apparatus for surveying and measurements of all sorts.

Electrical Observatory.—An electrical observatory is contemplated for the Calcutta Presidency College.

King's College Engineering Society.—A meeting of the above Society took place on Friday, October 15th, when Mr. N. B. Rosher, A.I.E.E., read his presidential address, the subject chosen being, "The Electric Lighting of a Private House." The author explained the various systems of wiring now in use, pointing out their several merits and demerits; he then went on to show how the various rooms of a house should be lighted. The many forms of joints, lamps, switches, and fuses in use were dwelt upon. Several samples of the systems described were exhibited. After a short discussion, the meeting accorded a hearty vote of thanks to the author.

Subways for Underground Tubes.—Electric supply companies in the metropolis are interested equally with the gas and water companies in any attempts made to compel them to make use of subways for the accommodation of their mains. So far, there is no question of compulsion; but from the report presented by the Improvements Committee at Tuesday's meeting of the London County Council, it appears that it is intended to seek powers to render it obligatory on the part of the companies to place new pipes in *any future* subways, and to remove those already existing into the same underground passages.

Free Wiring.—A New York electrical contemporary, in a recent note, commends the "free wiring" methods now being adopted in this country to the attention of American electricity supply men. The writer says:—"The paths of electric lighting companies could be made smoother if some way could be found to relieve them, as well as the consumers, of the cost of wiring," and a way out of the difficulty has been found by the establishment of an English Free Wiring Syndicate. "We must say," adds the writer, "that the scheme commends itself to us as a very practical one, and well worth a trial in this country."

The Institution of Junior Engineers.—On Saturday, October 30th, at 3 p.m., a visit will be paid to the Queen's Road Station of the Central London Railway works.

Motor Cars.—A society has just been started in Berlin to promote the introduction of motor cars on the Continent. In discussing this enterprise, the *Elektrotechnische Zeitschrift* brings forward certain statistics to show that the electric car, with accumulators, is not so very far behind the petroleum motor car in weight and speed, and that for certain purposes, such as for cabs and parcel vans, the electric car has the advantage. A comparison is made between a Daimler benzine car and an electric car made by Kühlstein. Both these cars are capable of carrying five persons. If five persons are taken as weighing 400 kg., the comparison between the two cars is shown in the following table, using the figures given by the manufacturers:—

	Daimler.	Kühlstein.
Weight, fully loaded	1,550 kg.	2,000 kg.
Average speed per hour	12 miles.	8·4 miles.
Maximum speed per hour ...	15·6 „	12·8 „

The electric car contains 30 Correns cells, with a capacity of 250 ampere-hours. According to experiments by Correns, the Lundell motor on this car required 35 amperes on good stone pavement, 42 amperes on asphalt, and 60 amperes on the ordinary roads. One charge is sufficient to run 42 miles. The battery weighs 750 kg., and gives, with an average discharge current of 46 amperes, 14 kilowatt-hours, or 1 kilowatt-hour per 53 kg. of battery. The London electric cab, carrying three persons, weighs 1,500 kg., and has an average speed of 9·6 miles per hour. Its horse-power, compared with Kühlstein's car, is as 24 to 28, and the weight of the batteries as 70 to 75. Since the London cabs run 48 miles with one charge, the product of weight × run is 72 mile-tons, while with the Kühlstein car it is 84 mile-tons. Our German contemporary concludes, from these figures, that Kühlstein's car is 9 per cent. better than the London cab in power developed per unit weight of battery.

Infringement of Holophane Globes.—Mr. Justice Ridley heard a motion, in the Vacation Court on Wednesday, on behalf of the Holophane Company, to restrain Messrs. Oscar Berend & Co., electrical engineers, Basinghall Street, London, with agencies at Manchester, Birmingham, and other large provincial towns, from infringing their patent glass globes for electric lights. The defendants denied the infringement, and undertook to keep an account of all the alleged infringing globes. Upon this undertaking the motion stood over till the second motion day of the next sittings.

Electrical Contractors and Municipal Orders.—"They have been warned several times, but you cannot believe anything they say." Such were the words used by a borough electrical engineer to his Electric Light Committee, when complaints were made of the delays of contractors in executing orders for extension plant, the contract for which is 12 months (!) overdue. It was stated that the engineers' strike had no doubt been a lot to blame, but "the contractors wasted time during the early part of the year, and the job should have been completed long before the engineers' dispute commenced." The Committee decided that the contractor in question would have to wait for payment when something is applied for on account. Some contractors may, perhaps, consider that the engineer expressed himself too strongly. Whether that is so or not, we need not discuss here. If the contract is overdue 12 months, it is clear that the engineers' strike has not been to blame for more than 15 weeks' delay. A delay of eight to nine months is of grave importance whatever the cause, for it might be a very serious matter to many municipalities waiting for extension plant; and, moreover, the contractor who looks upon a promise from the pie-crust point of view is scarcely justified in looking for repeat orders. What is to be deprecated is the method of assuring customers of delivery on a certain date, when there is little likelihood that such a promise will be kept. This is a matter to which we think the attention of contractors may be profitably directed.

NEW COMPANIES REGISTERED.

Self-Generating Electric Vehicle Light Syndicate, Limited (54,415).—Registered October 13th with capital £5,000, in £1 shares, to adopt an agreement with A. M. Armstrong, and to carry on the business of electrical and mechanical engineers, proprietors of wagons, carriages, and other vehicles, carriers, jobmasters, &c. The subscribers (with one share each) are: T. Taylor, 28, Sumner Road, Croydon, clerk; J. Barker, 18, Croydon Grove, West Croydon, insurance broker; B. V. Jones, 27, Chancery Lane, E.C., solicitor; D. H. Ross, 6, Frederick's Terrace, Camberwell, clerk; H. Ross, 19, Grummant Road, Peckham, clerk; W. H. Butts, 24, Ross Road, Wallington, agent; E. H. Ablitt, 20, Bishopsgate Without, E.C., broker. Registered without articles of association. Registered office, 3 and 4, Crooked Lane, King William Street, E.C.

Edward Foster & Son, Limited (54,427).—Registered October 14th with capital £50,000, in £5 shares (5,000 £5½ cumulative preference), to acquire and carry on the business of brass founders and finishers, mechanical, sanitary and electrical engineers, &c., carried on as "Edward Foster & Son" at the Central Brass Works, Halifax, and at Hope Street, Bradford, and to adopt a certain agreement. The subscribers (with one share each) are:—W. H. Foster, South Grove, Halifax, brass founder; J. Frobisher, 12, First Avenue, Halifax, manager; C. Waghorn, 32, Stoodley Road, Halifax, secretary; T. J. Dobbing, 107, Queen's Road, Halifax, book-keeper; H. H. Stocks, 81, Saville Park Road, Halifax, outfitter; E. Booth, 11, Heath Mount, Halifax, solicitor; J. H. Helliwell, 19, Swires Road, Halifax, solicitor. The number of directors is not to be less than three nor more than seven; the first are W. H. Foster (chairman and managing director), R. Irvine, jun., H. H. Stocks, J. M. Jackson, J. Frobisher and J. Barlow. Qualification £500. Registered by E. J. Evershed, 61, Carey Street, W.C.

Prism Globe Syndicate, Limited (54,451).—Registered October 15th with capital £25,000, in £1 shares, to adopt an agreement with E. Stanley, and to carry on the business of glass manufacturers and blowers, prism globe manufacturers, electrical and mechanical engineers, electricians, suppliers of electricity, &c. The subscribers (with one share each) are:—J. S. Raworth, C.E., Christchurch Road, Streatham; W. Tatham, Grasmere, Surbiton, engineer; W. P. J. Fawcus, Derwent Bank, Keswick, engineer; S. Clirehugh, Fern Bank, Egerton Road, Manchester, engineer; E. J. Piper, 34, Victoria, S.W., engineer; W. M. Mordey, 4, Victoria Mansions, S.W., electrical engineer; S. Morse, 4, Fenchurch Avenue, E.C., solicitor, The number of directors is not to be less than three nor more than five; the subscribers are to appoint the first. Qualification £100; remuneration £500 per annum, and a share in the profits divisible. Registered office, Dashwood House, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Times Electric Lamp Company, Limited (52,005).—This company's statutory return has just been filed; 607 shares have been taken up out of a capital of £100,000 in £1 shares; £1 per share has been called and £7 paid, leaving £600 in arrears.

Sunbeam Lamp Company, Limited (25,498).—This company's annual return was filed on August 23rd, when 1,760 shares were taken up out of a capital of £25,000, in £10 shares. 857 of these are considered as paid, and £10 per share has been called, and £9,030 paid on the others.

Siemens Brothers & Co., Limited (14,777).—This company's annual return was filed on August 20th, when the whole capital of £500,000, in £100 shares was taken up; £85 per share has been called, and £425,000 received.

CITY NOTES.

Eastern Extension Telegraph Company, Limited.

The report of the directors of the Eastern Extension, Australasia and China Telegraph Company, Limited, for the half-year ended June 30th last, to be submitted to the ordinary general meeting to be held at Winchester House on 27th inst., states that the gross receipts, including Government subsidies, have amounted during that period to £290,7[illegible], as against £313,915 for the corresponding half-year of 1896. The working expenses, including £25,840 for cost of repairs to cables and expenses of ships, absorb £99,426, against £87,256 for the corresponding period of 1896, leaving a balance of £191,323. From this is deducted £4,308 for income tax, £31,895 for interest on debentures, debenture stock and contribution to sinking fund, and £1,605 for special donations, leaving £153,515 as the net profit for the half-year, which, with £18,798 brought forward from the previous half-year, shows an available balance of £172,313. Two quarterly interim dividends of 1½ per cent. each, amounting to £62,500, have been paid for the half-year, leaving £109,813, of which £75,000 has been transferred to the general reserve fund, and the balance of £34,813 is carried forward. The Government of Queensland having decided to join the other Australasian Governments in the guarantee arrangements entered into with the company, the tariff between Queensland and Europe was reduced on July 1st last from 9s. 5d. to 5s. 1d. per word. From the same date the reductions of tariff announced for China, Japan, Straits Settlements, &c., were also brought into force. The contract made with the Dutch Government for the manufacture and laying, on account of that Government, of two short cables in Netherlands-Indian waters, was satisfactorily completed during the half-year under review.

Monte Video Telephone Company, Limited.

The annual general meeting of this company was held at Winchester House yesterday, Mr. Herbert Ward presiding. The Chairman said in spite of the unsettled state of Buenos Aires, the company had not suffered as much as might have been expected, there being a substantial improvement on last year's figures. The number of subscribers down to July showed an increase of 46, giving an increase of £300 on the amount of subscriptions, while the working expenses showed a decrease of £1,040. Under that heading last year exceptional expenditure had been rendered necessary owing to the damage done by cyclones. The normal expenditure had previously been brought down to the lowest point, and they could not look for any material decrease on the present figure. After referring to the item of stock written off, the chairman said the interest on the securities was a little more than it was last year, but a still more satisfactory feature was that the value of those securities at the previous day's middle prices showed an appreciation of some £700 above the price at which the stood in the balance sheet. They were enabled to pay a 4 per cent. dividend on the preference shares, to place £500 to reserve fund, and to carry forward £976, making, altogether, a very satisfactory showing for 12 months. He was convinced that when the country settled down their telephone business would expand, and give an increased dividend.

The Brazilian Submarine Telegraph Company, Limited.

The directors' report for the half-year ended June 30th, 1897, to be submitted to the general meeting on October 27th, 1897, says that the revenue for this period amounted to £79,133 9s., and the working expenses to £20,505 7s. 4d. After providing £3,200 for debenture interest and sinking fund, and £1,481 8s. 8d. for income-tax, there remains a balance of £53,946 13s.; to this is added the sum of £15,274 12s. 5d. brought forward from December 31st last, making a total of £69,221 5s. 5d. A quarterly interim dividend, amounting to £19,500, has been paid, and £10,000 transferred to the reserve fund. The directors now recommend the declaration of a final dividend of 3s. per share, making, with the interim dividends, a total dividend of 6 per cent. for the year, and also the payment of a bonus of 2s. per share, both free of income-tax, which together will amount to £32,500, leaving a balance of £7,221 5s. 5d. to be carried forward. The dividend and bonus will be payable on the 28th inst. The Rt. Hon. St. John Brodrick, M.P., and Sir Albert J. Leppoc Cappel, K.C.I.E., retire at this meeting, and being eligible for re-election as directors offer themselves accordingly. The auditors, Messrs. Deloitte, Dever, Griffiths & Co., and Messrs. Gane, Jackson, Jeffereys & Wells also offer themselves for re-election.

The Petroleum Engine Company, Limited.

The report of the directors states that the royalties received for the year amount to £426 18s. 9d. The directors in their previous report drew attention to the keen competition in fixed engines to which Messrs. Priestman Bros., Limited, were subjected. They regret to state that this competition is still severely felt, and has resulted in a falling off in the receipts for royalties. Under these circumstances they are unable to recommend the payment of a dividend, and advise that the credit balance of the income and expenditure account for the year under review, amounting to £41 14s., should be carried forward.

The Manchester Mutual Telephone Syndicate, Limited.

A meeting of the members and supporters of the Mutual Telephone Syndicate, Limited, was held in the Chamber of Commerce on 13th inst., preceded by a luncheon at the Queen's Hotel. Mr. William Thompson presided at the former. At the close of the repast, the Chairman explained the position of affairs. The desire of the syndicate, he said, was to get a good telephone service at the least cost, and to break down the existing monopoly. The Mayors of Macclesfield, Stockport, and Stalybridge, spoke in support of the new Mutual Telephone, and in condemnation of the present monopolistic system. Alderman R. Robinson (Salford) also spoke approvingly of the venture, which was not to make money, but to benefit users, and this was strongly upheld by Mr. Evans, the President of the Rochdale Chamber of Commerce. At the meeting in the Chamber of Commerce afterwards, Mr. Hockheimer presided; there was a full attendance, and speeches were made approving of the action which had been taken by the syndicate, which was not to make money, but to establish an independent service at a reasonable cost. Mr. Thompson detailed the progress of the movement hitherto, and said nearly 7,000 subscribers had been secured. Speeches were delivered in support of the new company, and several gentlemen present promised to double their shares.

Chelsea Electricity Supply Company, Limited.—This company has been inviting subscriptions for an issue of 8,000 ordinary shares of £5 each (being the balance of the authorised share capital) at a premium of £4 10s. per share. The list closed at 4 p.m. yesterday, Thursday. 26,000 ordinary shares and the 6,000 preference and 500 founders' shares have been issued, and are fully paid up. £60,000 four-and-a-half per cent. debenture stock has been issued, and the directors have power to issue, from time to time, debenture stock to the amount of the subscribed share capital for the time being. The premiums from the present issue will be added to the reserve fund, which is at present £15,865. The new capital is required for plant and buildings necessary to meet the continually increasing demand for current. Over 18,000 lamps have been added to the company's circuits during the past twelve months, and the area is such that continual additions may be looked for for some years.

The Eastern and South African Telegraph Company, Limited.—The directors announce the payment by warrants, on November 1st, of interest on its 4 per cent. Mauritius subsidy debentures for six months to October 31st. The transfer books will be closed from October 26th to November 1st, both days inclusive.

The Eastern Telegraph Company, Limited.—The directors announce the payment by warrants, on November 1st, of interest for the half-year ended October 31st on its 4 per cent. mortgage debenture stock. The transfer books will be closed from October 28th to November 1st, both days inclusive.

Oriental Telephone and Electric Company, Limited.—The directors have to-day declared an interim dividend of 4d. per share, free of income-tax, payable to those shareholders whose names are on the register at this date. The warrants will be posted 30th inst.

The Windermere Electricity Supply Company, Limited.—The share applications received for this company are far beyond what the directors require. The list closed on Friday, and allotment letters have been posted.

Callender's Cable and Construction Company, Limited.—The directors have delared an interim dividend of 4s. per share, being at the rate of 8 per cent. per annum, payable on November 1st.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending October 17th, 1897, were £960; week ending October 18th, 1896, £1,012; decrease, £52; total receipts for half-year, 1897, £14,550; corresponding period, 1896, £14,692; decrease, £142.

The Liverpool Overhead Railway Company. The receipts for the week ending October 17th, 1897, amounted to £1,296; corresponding week last year £1,081; increase, £215.

The Western and Brazilian Telegraph Company, Limited. The receipts the week ending October 15th, 1897, after deducting 17 per cent. of gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,720.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. †	Dividends for the last three years. 1894.	1895.	1896.	Closing Quotation, Oct. 13th.	Closing Quotation, October 20th.	Business done during week ended October 20th, 1897. Highest.	Lowest.
149,900£	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	4 %	...	100—104	101 —105	...	...
25,000	Amazon Telegraph, Limited, shares...	10	...	...	...	5 — 6	5½ — 6½	...	...
923,960£	Anglo-American Teleg., Ltd.	Stock	£2 2s.	£2 9s.	£2 13s.	59 — 61	58 — 60xd	58⅝	58⅛
3,038,020£	Do. do. 5 % Pref.	Stock	£4 4s.	£4 18s.	£5 6s.	105 —106	104½ 105½xd	105½	104⅝
3,038,920£	Do. do. Defd.	Stock	...	...	...	13¼— 13⅜	12⅝ - 13⅛	13⅛	12⅝
130,000	Brazilian Submarine Teleg., Ltd.	10	7 %	7 %	...	15⅛— 15⅜	16 — 16½	16¼	15⅛
75,000£	Do. do. 5 %, Debs., 2nd series, 1926	100	5 %	5 %	...	113 —117	114 - 118	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	2½%	4 %	4 %	3½— 3⅝	3½ - 3⅝	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	178 —183 xd	178 —183	...	...
653,586£	Do. Do. Sterling 500 year 4% Deb. Stock Red.	Stock	...	...	...	107 —108	105 —107	106¾	105¾
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	1½%	1½%	2 %	1/16— 1/8	1/16— 1/8	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	8½— 9½	8½ — 9½	9 7/16	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	18½— 19½	18½ — 19½	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 11	10 — 11	...	...
30,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000	50	4½%	4½%	4½ %	103 —106 %	103 —106%	...	...
60,710	Direct United States Cable, Ltd.	20	2 %	2½%	2½ %	10 — 10⅛	10½— 10⅝xd	10⅜	10½
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6¼%	6½%	6½%	16⅜— 17⅛	16¾— 17⅛xd	17⅛	17
70,000	Do. 6 % Cum. Pref.	10	6 %	6	6%	18 — 19	18 — 19 xd	18¾	18 7/16
89,900£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	5%	101 —104	101 —104	...	...
1,302,615£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	4%	130 —135	131 —134	...	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd.	10	7 %	7 %	7 %	17½— 18	18 — 18¼xd	18 5/16	17⅞
35,500£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	5%	99 —103	100 —104	...	...
133,100£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5%	100 —103	101 —104	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	4%	122 —132	129 —132	...	...
51,100£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	5%	99 —103	100 —104	...	...
69,200£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	5%	100 —103	101 —104	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	4%	103 —106	103 —106	105½	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4%	108 —111 %	109 —112%	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4½%	4½%	4½%	11¼— 12	11½— 12	11 15/16	11⅝
180,042	Do. do. 5 % Pref.	10	6 %	6 %	6%	16⅝— 17¼	17⅛— 17⅝	17 5/16	17⅛
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜%	10 %	10⅜	26½— 27⅜	26¼— 27½	26¾	...
160,000£	Do. do. do. 5 % Debs.	100	5 %	5 %	5%	102 —105	102 —105	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10%	54 — 57	54 — 57	56¾	...
100,000£	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6 %	6%	106 —110	107 —110	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000...	5	4 %	4 %	...	2 — 2½	2 — 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 %	5½%	5½%	6⅞— 6⅞	6⅝ — 6⅝	6 13/16	6 7/16
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	16 1/16	15½
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	...	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6 — 6½	6 — 6½	6 5/16	6⅛
130,766	Do. do. Nos. 119,235 to 250,000, £3 paid	5	...	...	...	3⅜— 4¼	3¾— 4¼	...	...
1,329,471£	Do. 3½ % Deb. Stock Red.	stock	3½%	3½%	3½%	105 —110	104 —109	106	105½
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	4½%	5 %	5 %	9/16— 11/16	9/16— 11/16	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs. 1 to 1,000	100	4 %	4 %	4 %	107 —110	107 —110	...	...
11,839	Reuter's Ltd.	8	nil	5 %	5 %	7 — 8	7 — 8	7 13/16	7⅞
3,381	Submarine Cables Trust	Cert.	...	...	...	138 —143	135 —140	137	...
58,000	United River Plate Teleph., Ltd.	5	3 %	4 %	...	3⅜— 4¼	3⅜— 4¼	...	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	5 %	...	102 -107	102 —107	...	...
15,609	West African Teleg., Ltd., 7,561 to 22,169	10	nil	4 %	nil	5 — 6	5 — 6	...	...
213,400£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	103 - 106	103 —106	...	...
64,256	Western and Brazilian Teleg., Ltd.	15	3 %	3 %	2 %	9½— 10	9½— 9¾	10 3/16	9⅝
33,129	Do. do. do. 5 % Pref. Ord.	7½	5 %	5 %	5 %	7½— 7¾	7½— 8	7¾	7⅝
33,129	Do. do. do. Def. Ord.	7½	1 %	1 %	...	2¾ - 3¼	2¼— 2¾	3	2½
382,230	Do. do. do. 4 % Deb. Stock Red.	Stock	...	...	...	103 —106	106 —109	107	...
88,321	West India and Panama Teleg., Ltd.	10	1%	1%	...	...	3/16— 1	15/16	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	1 %	3/16 - 1	9¼ — 10¼	10 3/16	9 1/16
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	10 — 10½	7 — 8	7⅞	...
80,000£	Do. do. do. 5 % Debs. No. 1 to 1,600	10	6 %	6 %	6 %	7½ - 8¼	107 —110	...	...
1,163,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds	100	7 %	7 %	6 %	106 —109	106 —110	...	...
160,100£	Do. do. 5 % Ster. Bonds.	$1000	6 %	6 %	7%	106 —110	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	4½%	5 %	6 %	12 — 13	12 — 13	12¼	12⅛
20,000	Do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 — 6⅛	6 — 6½	6⅜	6¼
26,000	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277	5	5 %	5 %	5 %	10¼ — 10⅜	10½ — 10⅝	10½	10¼
60,000	Do. do. do. 4½ % Deb. Stock Red.	Stock	...	4½%	4½%	110 —113	10 —113	...	..
40,000	City of London Elec.Lighty. Co., Ltd., Ord. 40,001—80,000	10	5 %	5 %	7 %	25 — 26	25 — 26	25⅜	25 7/16
10,000	Do. do. Prov. Certs.	5	...	...	...	24 — 25	24 — 25	...	...
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	17 — 18	17 — 18	17⅜	17 3/16
400,000	Do. do. 5 % Cum. Pref., 1 to 40,000	...	5 %	5 %	5 %	131 —136	131 —136	133½	132
22,475	Do. 5 % Deb. Stock, Scrip. (iss. at £115), all paid	10	...	nil	nil	12⅜— 13¼	12⅜ — 13¼	13	12 13/16
20,000	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—22,475	10	...	6 %	6 %	15¼— 16	15½ — 15⅝	15 3/16	15½
10,000	Do. do. do. 6% Pref., 40,001—60,000	5	...	...	...	9 — 9¼	9 — 9⅛	...	...
49,900	House-to-House Elec. Light Supply, Ord., 101 to 10,100	10	3 %	4 %	...	10¾— 11¼	10⅝— 11¼	10 15/16	10¾
12,500	Do. do. 7 % Cum. Pref.	5	...	...	5 %	18 — 19	17½ — 18½xd	18⅜	...
220,000£	*Metropolitan Electric Supply, Ltd., 101 to 50,000	10	...	...	...	17 — 18	17 — 18	17 13/16	...
6,452	Do. Ord., 50,001—62,500, iss. at £2 prem.	...	4½%	4½%	4½%	119 —123	119 —123	122½	119½
19,980	Do. 4½% first mortgage debenture stock	10	1 %	2 %	4 %	15 — 16	15 — 16	15¾	15⅝
20,000	Notting Hill Electric Lightg. Co., Ltd. Ord., 101-20,080	5	6½%	7½%	10½%	16 — 17	16 — 17	...	...
50,000	*St. James's & Pall Mall Elec. Light Co., Ltd., 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9½— 10½	9½ — 10½	...	...
43,341	Do. do. 4 % Deb. stock Red.	Stock	...	...	...	103 —106	103 —106	...	...
67,900	South London Electricity Supply, Ord., £2 paid	5	...	...	...	1⅜— 2¼	1⅜— 2¼	2 1/16	1⅞
	Westminster Electric Supply Corp., Ord., 101 to 68,000	5	5 %	7 %	9 %	14½— 15½	14⅜ — 15½	15⅜	14⅜

* Subject to Founder's Shares.

† Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid.

§ Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

‖ Dividends paid in deferred share warrants, profits being used as capital.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Shares ‡	Dividends for the last three years. 1894.	1895.	1896.	Closing Quotation Oct. 13th.	Closing Quotation, Oct. 20th.	Business done during week ended Oct. 20th, 1897. Highest	Lowest.
20,000	British Electric Traction	10	...	...	...	12¾ — 13¼	12¾ — 13¼	12 15/16	12 13/16
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000...	8	2½%	...	...	1 — 1¼	1 — 1¼	...	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	3 %	...	...	1⅞ — 2⅛	1⅞ - 2⅛	2	1 15/16
125,000£	Do. do. 4½ % Perp. Deb. Stock.... ...	Stock	4½%	...	...	103 —107	105 —109	107	...
76,770	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	96 —100	98 —102	10	...
19,126	Central London Railway, Ord. Shares	10	...	...	...	9⅜ — 10¼	9⅜ — 10¼	10	9 13/16
143,106	Do. do. do. £6 paid	10	...	...	...	5¾ — 6¼	5½ — 6	5 13/16	...
58,830	Do. do. Pref. half-shares £1 pd. ...	...	...	...	...	1¼ — 1⅝	1 — 1½	1	...
61,777	Do. do. Def. do. £5 pd. ...	...	...	...	...	4¼ — 4⅝	4 — 4½	4	...
630,000£	City and South London Railway	Stock	1½%	1 3/16%	1 9/16%	69 — 71	69 — 71	70⅜	70
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	*nil*	*nil*	...	1½ — 2	1½ — 2	...	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	5 %	5 %	5½%	2¼ — 2⅝	2¼ — 2⅝	2 9/16	2¼
17,139	Do. do. do. "A" Shares 01—017,139	5	5 %	5 %	5½%	4 — 5	4 — 5	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	5 %	6 %	2 — 2¼	2 — 2¼	2⅛	2 1/16
16,343	Do. do. 7 % Cum. Pref., 1 to 16,343 ...	2	7 %	7 %	7 %	3⅛ — 3⅜	3⅛ — 3⅜	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	...	...	⅜ — ⅝	⅜ — ⅝	...	...
67,275	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	...	...	⅜ - ⅝	⅜ — ⅝	...	...
9,600£	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	*nil*	10½%	...	9 — 11	9 — 11	...	...
12,500	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	6 %	8 %	10 %	19 — 20	19 — 20	...	...
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	18½ — 19½	18½ — 19½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	4½%	4½%	110 —115	110 —115	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	10 %	10 %	10 %	21½ - 22½	21½ - 22½	22¼	...
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	103 —107	103 —107	...	...
87,500	Liverpool Overhead Railway, Ord.	10	1½%	2½%	2¾%	11⅜ — 11½	11½ — 11⅝	...	...
10,000	Do. do. Pref., £10 paid	10	5 %	5 %	5 %	16 — 16½	16 — 16½	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	15 %	15 %	36 — 39	36 — 39	37⅝	37¼
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	102 —105	102 —105	...	...
54,000£	Waterloo and City Railway, Nos. 1 to 54,000	10	...	...	...	12½ — 13	12¾ — 13¼	13	12¾

Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.
Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.
Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0*/16; 1891—7*/16; 1890—8*/16.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (£4 paid), 7⅞, £5 (fully paid) 9½.

Electric Construction Corporation, 6 % Debentures, 104—106.

House-to-House Company, 4½% Debentures of £100, 109 –111.

Kensington and Knightsbridge Electric Lighting Company, Limited Ordinary Shares £5 (fully paid) 13½—14½; 1st Preference Cumulative 6 %, £5 (fully paid), 8—8½. Dividend, 1896, on Ordinary Shares 7 %.

London Electric Supply Corporation, £5 Ordinary, 2—2¼.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 8—8½. Dividend for 1896—6 %.

* From Birmingham Share List.

Bank rate of discount 2 per cent. (May 13th 1897).

MUSCULAR ELECTRICITY.

By J. WRIGHT.

(*Continued from page* 503.)

When a momentary impulse therefore is applied to a nerve connected to a muscle, the following phenomena occur:—

"1. The generation at the spot stimulated of a nervous impulse, and the propagation of the impulse along the nerve to the muscle. The time taken up by this varies according to the length of the nerve, but is always very short.

"2. The setting up of certain molecular changes in the muscle, unaccompanied by any visible alteration in its form, constituting the latent period, and occupying on an average about $\frac{1}{100}$ second.

"3. The shortening of the muscle up to a maximum, occupying about $\frac{4}{100}$th second.

"4. The return of a muscle to its former length, occupying about $\frac{5}{100}$th second."

The length of the latent period varies according to the different muscles and conditions. According to Helmholtz, it is $\frac{1}{100}$th second; Yeo, $\frac{1}{200}$th second; and B. Sanderson, $\frac{1}{400}$th second. The form of the curve also varies according as to the manner in which the muscle is "loaded." A muscle is said to be "after-loaded" when it is caused to perform work in raising a weight or lever in contraction, but which is not stretched by the latter when at rest.

"Isotonic" curves are the result of muscular contraction against a small and steady resistance, and most of the experimental curves obtained from muscle are of this nature. An "isometric" curve, on the other hand, is produced by muscular contraction against a large resistance, such as a dynamometer spring.

The muscle curves also vary considerably under such variable conditions as temperature, fatigue, &c.

We now come to what are known as "tetanic" contractions, produced by a succession of stimuli such as the shocks from a frequently interrupted current.

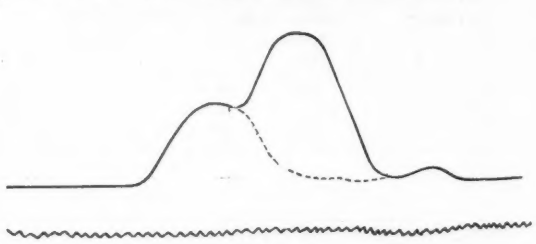


Fig. 6.

Fig. 6 represents an rve obtained by a series of two shocks the second of which was administered at such a time as to complete its latent period just as the curve resulting from the first shock has passed its maximum. It will be observed from this compound curve that the result of the second shock was to cause the muscle to contract again to an almost equal extent.

On increasing the number of shocks a similar result is obtained, but each succeeding contraction to the first is slightly less, and the resulting curve is as shown in fig. 7, where the impulses were applied by a current having 16 interruptions per second. The duration of this curve was four seconds, as shown by the divisions on the base line, each of which represents one second.

When the shocks succeed one another more rapidly still, the curve resolves itself into an even line, as shown in fig. 8.

This condition of the muscle, brought about by rapidly succeeding shocks, is known as "tetanus," or "tetanic contraction."

There are three definitions relating to muscular contraction consequent on induced shock to which I have not yet alluded, but will now proceed to do so. A "Maximal" stimulus is one which causes a muscle to contract to the

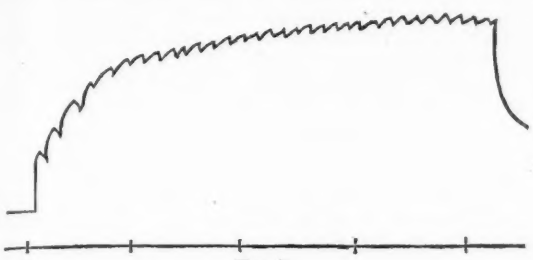


Fig. 7.

maximum extent of which it is capable, as the direct result of a single induction shock. A "Submaximal" stimulus is one which results in a lesser contraction than the above, whilst a "Minimal" stimulus is the weakest current, which, when applied to a muscle, produces contraction.

So far we have only discussed the induced current stimuli, but similar effects are possible both at "make" and "break" of a constant current; the steady application of the latter

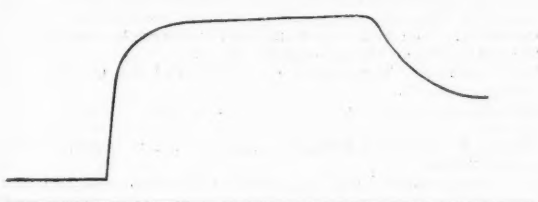


Fig. 8.

has, however, no effect on the muscle which remains quiescent. To prove this rule, there must be, of course, exceptions, and these are to be found in what is known as "Wundt's tetanus," which is a lasting contraction sometimes occurring in frog's muscle traversed by a strong current, and in human muscle as "galvanotonus"—this results in ordinary muscle during the passage of a strong current.

Another interesting effect in connection with the application of stimuli to muscle is, that one portion begins to contract before the other, the contraction taking the form of a wave which spreads outwards from the point of application. According to Aeby, the speed of this wave in frog's muscle is from 1 to 3 metres per second. It has been proved experimentally that the make contraction starts from the cathode and the break contraction from the anode, or, as Waller puts it, "The make stimulus is cathodic, the break stimulus anodic."

There are three effects of constant current stimulation which are worthy of investigation, viz:—

(*a*) Those resulting from the make and break.

(*b*) Those which diffuse themselves along the nerve on either side of the electrodes, and which are known as "electrotonic currents."

(*c*) The variations in excitability consequent on the latter.

In order to render the explanation as clear as possible, I will here refer to Pflüger's law of contractions, which is to the effect that the latter movements of the muscle consequent on make and break stimuli are evident or non-evident in a certain order.

In studying these phenomena, physiologists make use of the terms ascending and descending currents to indicate the direction of the latter. A current is said to be "ascending" when the electrodes are so arranged with regard to the nerve that it flows in a direction from the muscle towards the spinal cord. A "descending" current, on the other hand, has an opposite direction. These terms will be readily understood on reference to fig. 9, where A and B represent ascending and descending currents respectively; *a* is the muscle, *b* the nerve, and *c* the spinal cord, the electrodes being represented by the signs + and −. The direction of the currents in each case is represented by the arrows.

At make, the excitability of the current is lessened at the

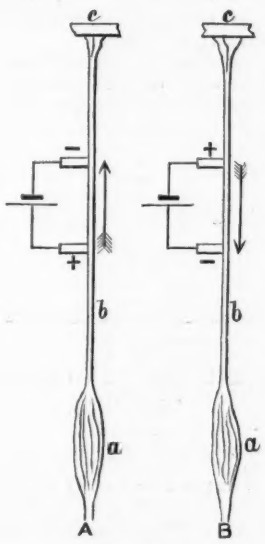


Fig. 9.

anode, and intensified at the cathode, and *vice versâ*. This proves our previous statement that at make the stimulus is cathodic, and at break anodic.

With a medium current the contraction of the muscle is evident at both make and break. With a weak current the make stimulus only takes effect, whilst with a strong current when ascending, the break contraction only is visible; with a descending current, however, the opposite effect is produced, only the make contraction being evident.

"Ritter's tetanus." This sometimes results at the break stimulus, and is supposed to be due to the post-anodic excitation.

"Electrotonus" is a term used to denote two distinct series of effects resulting in constant current stimulation of a nerve.

1. Currents in the nerve beyond the portion between the two electrodes. These are called "electrotonic currents."

2. Alterations of excitability of the nerve in and near the portion between the electrodes. This is called electrotonic alteration of excitability.

It will be necessary in describing these effects to introduce two new terms, viz., "anelectrotonic" and "catelectrotonic" currents, according to the position of origin of the latter with regard to the anode or cathode respectively. They will be as before, best understood by a simple reference diagram, such as in fig. 10, where A and B represent electrotonic

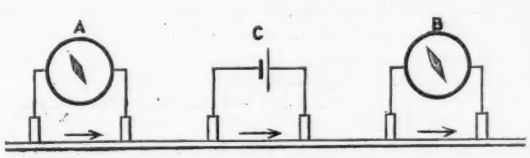


Fig. 10.

and catelectrotonic currents respectively, C being the original constant current source.

The direction and intensity of an electrotonic current as investigated by a pair of tapping electrodes leading to a galvanometer vary in accordance with the direction and intensity of the originating or, as it is termed, "polarising" current.

That the electrotonic current is dependent on the vital or anatomical integrity of the nerve in which it exists is proved by certain facts:—

(*a*) That it is abolished by a ligature between the polarised and electrotonic regions.

(*b*) That it is absent, or at least diminished, on dead and on degenerated nerve.

(*c*) That it is absent from tendon or a wet thread.

It is worthy of note that the anelectrotonic is stronger than the catelectrotonic current, and also that both currents are increased by a lengthening of the distance between the originating electrodes, provided that the E.M.F. be raised the necessary extent to overcome the consequent increase in resistance between the electrodes.

After-electrotonic effects are produced when the originating current ceases, and their direction in that portion of the nerve between the electrodes is opposite to the original direction of the polarising current, except where the latter is strong and of short duration, when the resulting after effect is in the same direction. This is called by Du Bois Reymond a positive polarisation current, and has been proved by Hermann to be a current arising from post-anodic excitation.

(*To be continued.*)

DIFFICULTIES OF TRANSPORT IN THE TROPICS.

A SEMI-AMUSING, but at the same time instructive article, recently appeared in the *Engineering Magazine* from the pen of Mr. C. P. Yeatman, on the difficulties of transport in the tropics, and the serious hindrance such difficulties place in the way of industry generally.

The Central American State of Columbia is taken for illustrative purposes. Here there is a railway about 18 miles long of 3 feet 6 inches gauge, to the port of Barranquilla, to which port it is carried by this railway from an ocean pier of steel some 4,000 feet long, as the river is not practically navigable from its mouth to Barranquilla. From the port, however, river steamers carry freight up the river. They are from 150 to 300 tons burden. So far all is well; the trouble comes when this river is left, and mules or men have to be relied upon. A mule load is only 125 lbs., and when a packet exceeds the mule limit, the cost at once goes up with a bound. Men, it seems, surpass mules in carrying power. A woman pack carrier speaks of her load as "only 220 lbs.," and should you suggest it is too much for her, feels aggrieved, says she is but part grown up, and refers you to her grandmother for real load-carrying ability. A man's load is 12 arrobas, or 330 lbs., a woman's 9 arrobas, as a maximum. Such loads cost £30 for 100 miles, or over 40s. per ton mile. Mule packages vary from about 2s. 9d. to 12s. 6d. per ton mile, according to circumstances. If a package is too heavy to deal with by carrying, it is dragged by a windlass and rope fixed ahead on the road, and simply on wood runners — not on wheels. Pieces of machinery for the Government Mint are recorded as being five years on the road to a city only 100 miles from the Magdalena River, and even then had got half way only at a cost of £3,000. In carrying rails the plan of dragging them two together by one mule, with ends dragging on the floor, proved unsuccessful, because the ends wore off. After that two mules carried two rails between them of 20 feet in length, and 35 lbs. per yard, and they soon learned to keep step. A contractor who was short of 12 30-foot rails, bought them from a railway some 90 miles distant. They cost him £300 to transport. To carry a bag of coffee the 80 miles from the 3,000 feet elevation to the river costs $8.50. Then it costs $1.92 per river, 500 miles to Barranquilla, and $0.33 for the 18 miles of rail. Thence 3,000 miles to New York costs $0.40. Yet the Colombian considers he is swindled by the steamer, the railway, and the river boat, to whom he pays but 38 per cent. of what his friend the mule costs him.

The average railway charge is $6.67 per ton in paper or $2.67 gold, equal to 15¼ cents per ton mile, a trifle high as compared with the average in the United States of $0.0084. But the railway does all the port handling and weighing, and pays 3 per cent. of gross freight earnings to the Government as well as a further state tax. Other railroads charge four and five times the ton mileage charged by this Barranquilla railroad. Further, all the lines receive in paper and pay out in gold, and are in daily sight of a State revolution. American consuls go to Columbia with great ideas of booming things. The author himself met many boomers when he first went there nineteen years ago. All not yet dead or departed have had the boom fever quenched. Traffic year by year fluctuates badly, and some years goes very low, on account of the revolutions. We all know what good little boys the Central Americans are. At present Uncle Sam looks on them as an excuse for occasional ill-bred bluster about England. Mr. Yeatman seems to have a better and truer estimate, however.

The article should be instructive to all who would send machinery to such countries. We once heard a man arguing for some cheaper quotation for work to be done in the middle of an island somewhere East. The engineer who knew, just asked him to suppose his various packages laid down in Leadenhall Street, and to be carried to Dorking across the fields without other help than blacks. Exporters should bear these things in mind?

GLASGOW TELEPHONE INQUIRY.

SEVENTH DAY'S EVIDENCE.

(*Continued from page 524.*)

WILLIAM JOHNSTON, of the Town Clerk's department, examined by Mr. SALVESEN, said a circular with reply post card had been sent out to ascertain how many subscribers could be got to a proposed municipal exchange; 20,000 circulars were sent out, and 3,043 cards returned. The replies showed that the senders would take 4,188 instruments. The minimum number of instruments were taken; if the maximum number had been adopted there would have been many hundreds more. The present requirements of the Corporation departments were 402, so that there was a minimum calculation in all of 4,590 instruments. Of the replies, 1,254 were from subscribers to the National Telephone Company. The number of instruments indicated by them was 2,233, or, including the Corporation departments, 2,535.

In cross-examination by Mr. BALFOUR, WITNESS said the circulars were sent to every person in business whose name appeared in the Glasgow Directory. That covered Glasgow as a commercial centre, apart from the municipal area.

ROOKES EVELYN BELL CROMPTON, in examination by Mr. SALVESEN, said he was an electrical engineer, past president of the Institute of Electrical Engineers, member of the Institute of Civil Engineers, and managing director of Crompton & Co., electrical engineers. Six years ago he was consulted by the Glasgow Corporation as to the electric light supply system. He advised the Corporation to carry out the work themselves. One of the reasons for giving that advice was, that all systems of electrical distribution which had to be placed underground necessitated interference with the streets, and the streets of Glasgow were exceptionally difficult to deal with. It was not possible to make use of the spaces under the footways in the manner that was usual in other towns. The space occupied by conductors for telephones was much less than for conductors for electric lighting and distribution. He had been informed that at present the Corporation had the sole control of the streets, and that there was nothing underlying the streets that did not belong to them, except some telegraph wires belonging to the Post Office. He did not profess to speak as an expert in telephony. Only 2 per cent. of the members of the Electric Engineers' Association professed to be acquainted with telephony.

What is the explanation of that?—Because the monopoly that has so long existed has prevented others entering the profession.

It restricts the number of experts almost entirely to those that the National Telephone Company employ?—Practically so. He thought that Glasgow, owning as it did the lighting service and the electric tramway service, would find itself in a very difficult position if it had another authority owning the telephone service in the same streets, and in close proximity to these heavy circuits. If the whole of the services were under one head, interference would be reduced to the smallest extent. He had seen the coned insulator used in Glasgow by the National Telephone Company. It was a very poor insulator, unfit for outdoor use. It was intended for indoor use. That leakage partly accounted for cross talk, as well as indistinctness of sound.

By Mr. ASHER: It was entirely a question of the space that was left as to whether a metallic circuit could be laid under the footpaths in Glasgow. The objection to metallic circuits being laid in the streets of Glasgow was that the care of the electric circuits would be under two heads—one the telephone engineer, and the other the Corporation engineer. By such a division the maintenance would be greatly increased. Any difficulty connected with cross currents between different electric wires would be the same, whether the circuit belonged to the Corporation or to the company, but the way of meeting the difficulty would be different.

ALPHEUS CLEOPHAS MORTON, architect, London, and M.P. for Peterborough from 1889 to 1895, said he had been appointed by the Metropolitan Commissioners of Sewers to attend this inquiry and give evidence. Witness spoke to an application made to the Com-

missioners by the National Telephone Company for leave to place wires underground. The representatives of the company were asked whether they would give a better service at a reduced cost, such as had been asked for for years. They would not do so, and the application was not entertained. So far as he had used the telephone the service was nothing like what it ought to be.

Arthur Barns Mountain, electrical engineer, Huddersfield, said he had acted as such for the Corporation of that town for seven years. He described how the National Telephone Company, in the course of negotiations with the Corporation, proposed to charge £10 for the first instrument and £8 10s. for all others. The Corporation referred the matter to witness, who found that an exchange of their own would result in the saving of a considerable sum of money. As instructed by the Corporation, he constructed a metallic circuit exchange, at a cost within a few pounds of £700, and there were in connection 42 instruments. The average annual cost of maintenance was £134 17s. 2d., or £3 4s. 2d. per instrument, as against £8 10s. which the National Company demanded. That represented a saving of £222 annually to the Corporation. An application had been received from the Telephone Company for leave to place their wires underground. At present he could not advise the Corporation to agree to such an application.

John Somerville, Associate of the Institution of Electrical Engineers, stated that he had had large experience in all kinds of telephone exchanges and construction. He concurred with Mr. Bennett in the scheme of telephone service which he had prepared for Glasgow. That system would be much more efficient than the present system of the National Company. He agreed with Mr. Bennett's estimate of cost of maintenance and of construction. So far as efficiency was concerned, a better metallic service in Glasgow could be given overhead than underground.

By Mr. Ure: The adoption of a metallic circuit would remedy such defects as overhearing and indistinctness.

William Thomson, consulting analytical chemist, Manchester, stated that in 1889—90 he worked along with Mr. Provand, with the view of establishing an independent telephone company in Manchester. The result was that the Mutual Company was established. The reason for the establishment of that company was because the service of the National Company was exceedingly bad and exceedingly dear.

An adjournment for luncheon was made at this stage.

On resuming,

Mr. Provand, M.P. for the Blackfriars Division of Glasgow, gave evidence with regard to the establishment in Manchester of the Lancashire and Cheshire Telephone Company, and subsequently of the Mutual Telephone Company. The Lancashire and Cheshire service was most unsatisfactory. The result of the initiation of the Mutual Company was that the National Company lowered their rates from £20 to £15, and then from £15 to £10, at which last figure it still remained. Every reform of price and service in this country at this moment was directly the result of the establishment of the Mutual Company in Manchester in 1890. Witness went on to refer to the telephone service at Bergen, in Norway, which he had visited. The population was about 55,000, and they had 1,800 subscribers, for a subscription of £3 16s. per annum. The capital outlay was £11 15s. 9d. per line. The company paid last year a dividend of 5¾ per cent. At Trondhjem, a town of 35,000 inhabitants, there was a municipal exchange, and the charge was £3 18s. for the first instrument and £2 5s. for a second. The radius was 1½ kilometres. For an instrument in private houses the charge was £1 15s. The concession extended to a radius of 4½ miles, but these charges were only for 1½ kilometres from the exchange. It was a single wire exchange, but it was going to be fitted with double wires. In Bergen and in Trondhjen he found that the girl operators were paid at a higher rate than was paid here—in some cases much higher. The men were not paid so highly as here. In Trondhjem the foreman had £5 8s. per month. The men got two week's holiday with full wages. They were insured against accidents, and they got full wages for a period if they were injured. The conditions were altogether very favourable so far as the workers were concerned. There was a fund for the girls to which the municipal exchange contributed, and it was given to them when they left the service. Both in Sweden and Norway the girls did not usually enter the company's service until they were about 18 years of age. They were all the daughters of professional men—lawyers, doctors, officers, and other men in good social position but not rich. The girls were well educated. In Christiania there were two exchanges, the central and the smaller exchange. The former had 6,475 wires, the latter about 700. The lines were still single wired, but the double wire service was to begin on January 1st next. Their tariff was, for each subscriber from the Central Exchange, £4 3s. 11d. per annum. For each 800 metres inside the municipal limits they charged an extra 8s. 4d.; outside the municipal limits each 500 metres extra was charged 11s. 3d. A dividend of 5½ per cent. had been paid. The return was limited to 6 per cent., anything beyond this figure being accumulated and applied to the improvement of the service. He had found that service to be good. Working expenses were said to be larger in this country than elsewhere, but if these could be followed out he believed it would be found that this was not the case. In Stockholm it was a metallic circuit throughout the whole area. Both in Amsterdam and Rotterham the exchanges belonged to a company down to last year, when the municipalities took over the business. They did not take over the exchanges, but built new ones. In Amsterdam the radius was rather more than three miles from the exchange. The service was continuous. The subscription was £7 10s. for the first instrument and £2 10s. for any other instrument afterwards. One of Ericsen's table instruments could be had extra for 4s. 2d. per annum. In Norway and Sweden, Mr. Provand further deponed, the girls worked six hours a day. In Amsterdam they worked seven hours. In some places the men worked about 60 hours a week. In Amsterdam they worked 10 hours a day. On the Continent they had free trade in telephones, here we had a protected system. What we suffered from here, and all we suffered from, was entirely ascribable to the action of the Post Office. He calculated that Glasgow would, down to 1911, pay the National Telephone Company in present circumstances nearly 1,000,000 sterling more than they would pay to a municipal exchange if it was established at £5 5s.

By Mr. Dickson: He would not admit that the Post Office gave a better and cheaper service than the National Company. Competition against the Post Office exchanges caused them to die out. He gave no reason for that; he only stated it as a fact which was shown in the Blue Book. His visit to the places he had mentioned was made last month. He did not speak Norwegian, Swedish, or Dutch. Everybody he met could speak English well.

Can you give me any case in which there is competition between companies and a municipality? The municipalities have been so good that competition could not live. In a competition between the Corporation of Glasgow and the National Company, I think the Corporation would be an easy first in time.

Re-examined by Mr. Salvesen: With the exception of the case of the Mutual, every private competitor had compelled the National Company to buy them up.

Are you aware that in competition with the Post Office the National Company put their rate sometimes down to nothing, and having killed them off put up their rates again?—Mr. Preece, of the Post Office, has referred to such a case. That would be a reason for the public leaving the Post Office. He (Mr. Provand) had no doubt that the Glasgow Corporation would manage the telephones better than the company. He thought so from what he had seen abroad and from what he knew of Glasgow. At present the Glasgow subscribers to the National Telephone got only a sixteenth or seventeenth share of the time and work of the board in London, who called them "provinciales."

Mr. Salvesen said that he had only one other witness to call, a member of the Manchester Corporation.

The Commissioner said he thought they had had enough about Manchester. An extraordinary post card had been sent to him stating that there gloves were sent to the operators the same as here.

The inquiry was adjourned till next morning, when the case for the National Telephone Company was opened.

Eighth Day's Evidence.

The case for the National Telephone Company was opened by Mr. J. B. Balfour.

Miss Wilhelmina Macfarlane was the first witness called. She said she had held the post as chief operator in the Royal Exchange since January, 1897. She had been in the employment of the Telephone Company since 1888, first in the South-Side Exchange, then in the Bridgeton Exchange, and lastly in the Royal Exchange, and for three years prior to January she acted as superintendent of the Royal Exchange. She was aware of certain complaints which had been made about the working of the telephone.

I should like to ask you in the first place as to the complaints of subscribers who have been told that the persons with whom they wished to communicate were engaged when in point of fact they were not engaged. What have you to say?—As regards answering "Engaged," it is sometimes owing to the subscriber failing to call off, thus preventing one subscriber from getting another. That is a very frequent cause. It is the fact that some subscribers are pretty constantly engaged during the business hours of the day for long periods. For instance, there are 3,346 (Messrs. P. & W. Maclellan), 1,173 (the Caledonian Railway Company), 1,174 (the Allan Line), 607 (the Clyde Shipping Company), and 773 (the Steel Company of Scotland). They are very seldom or never disengaged during the busier parts of the day. Continuing, witness said she had caused the number of calls of the Caledonian Railway to be counted for one day between the hours of nine in the morning and six in the evening. It was found that they numbered 112. This number did not include the calls of subscribers who wished to talk to them. Subscribers asked for them almost every minute in the day. If the witness, Mr. Anton Kufeke, used the telephone fifty times a day, it represented a very large use of the instrument, and it would not therefore surprise her if he was very often found engaged. An operator would never tell a subscriber a number was engaged unless she found it so. She had no interest or inducement to do so; her interest and inducement were all the other way.

A complaint has been made that subscribers have suffered inconvenience by being rung off before their conversations were completed; what do you say to that?—I should say that that is when the connection is with the trunk lines.

And you have nothing to do with that?—No. The Post Office.

Does such a thing ever happen in your experience in connection with the company's lines?—No.

Would you infer from the circumstances of Mr. Kufeke's complaint that it had reference to a trunk line?—Yes, I would.

Could the ringing off have happened in connection with the call wire for which the company is responsible?—No.

Continuing, Witness said that, in her opinion, the buzzing or burring sounds complained of were due to railway noises.

Has that been complained of where the lines go over the North British Railway?—Yes.

Have you found at times that there was some indistinctness and buzzing, especially when trains were passing through tunnels?—Yes.

Does the call wire sometimes get out of order through storms or similar causes?—Yes.

Is that generally for long or short periods?—About half an hour at a time.

Do subscribers sometimes show themselves a little impatient or unreasonable in pressing in numbers on the call wire?—Very often.

Is confusion created by subscribers sometimes talking with the

operator when pressing to get connected?—Yes, arguing with the operator and making the operator answer along the call wire.

Might that prevent other subscribers from hearing?—Yes, by occupying the wire.

When the call wire is properly used in the ordinary way, has the operator any difficulty in performing all the work connected with it?—None at all.

It is the subscriber's duty to call off; that is not a thing that the operator can do?—The subscriber must call off himself.

Witness, continuing, produced a statement of the local messages exclusive of trunk messages for September 15th, 1897, passing through the Glasgow exchanges. The statement was made up in eight columns, giving the different times the messages took to get through.

By Mr. Ure: Her duties as chief operator were to see that each operator was in her appointed place at the appointed time, that the duties of the operators were done to the best of their abilities, to see that everything was in proper working order, and that each operator was provided with instruments and that they were punctual as regards attendance. There were 111 girl operators under her at the head office. Each operator attended to a single call wire.

How many subscribers are on each call wire?—The number varies from 30 up to 60 perhaps.

How many call wires have as many as 60 subscribers on them?—I cannot tell.

How many have 50?—I really cannot answer that because I never counted them.

Can you tell me whether more have between 50 and 60 or between 30 and 40?—I fancy there would be more between 30 and 40.

How many call wires have you altogether?—66 I think.

Witness explained that some of the girl operators go on duty at seven o'clock in the morning and leave at four o'clock, with an interval of one hour for breakfast. During the time of duty they might have charge of a call wire on which there were 50 or 60 subscribers. Some operators come on at eight o'clock and go away at five. They all had an interval for dinner. Another set came on at nine o'clock and waited until six o'clock. Others came in at ten o'clock in the morning, remaining until seven o'clock. The night work was provided for until 8.30 by some of the girl operators who came on later in the day than the others. From 9 30 at night until seven o'clock next morning duty was taken by male operators. In addition to the interval of an hour for meals the operators had two intervals of a quarter of an hour, the one in the forenoon and the other in the afternoon. It was her duty to investigate complaints. They generally were that the answer "engaged" was given, that voices and noises were heard, that conversations were cut off, and delay in getting connection over the trunk wires.

Do you know whether in point of fact the complaints of subscribers in Glasgow have been more numerous than in other places?—About equal I should think.

Witness (continuing) said that when she got a complaint she asked the operator who had been attending to the instrument, and on the information she received from her she wrote her report.

You, of course, have to rely on the recollection of the operator?—Yes, in some cases.

And she may have to attend to 40, 50, or 60 subscribers on one call-wire?—Yes.

A reason why the answer engaged might be given when the wire was not engaged was that the click fault might be wrong, something wrong in the exchange in the jack, and if it is wrong in one place very often it is wrong throughout the room. The result was that a subscriber was engaged right down the room. Whenever she found this to be the case she reported it to one of the inspectors, who had it put right as soon as possible. Whenever a complaint was made of a subscriber always being engaged she at once caused an investigation to be made.

Do you know that sometimes a subscriber calls off three or four times, and gets no answer?—That may be the case occasionally; it may be because the call wire is, perhaps, out of order at the time. If a subscriber omitted to call off, his wire would, apparently, be engaged.

And does an operator not know from the fact that the call off has not been given for half an hour, or an hour, that it must have been omitted?—Yes, but she has no power to disconnect the subscriber until he calls off. She could ascertain, but she is not permitted to do so.

The Commissioner: What is the use of that regulation? The operator is not entitled, although she may be almost certain from the wire being engaged so long that a certain subscriber is not speaking, to ascertain whether a mistake has not been committed by the subscriber?—No, she is not allowed to do so, but she may, and she does. If a subscriber asks for a certain number several times, she communicates with one of my instruments, and I order one of my superintendents to see to it, and get the subscriber connected. This frequently happens, and I frequently get the answer that it was a mistake, they were done with the conversation.

Mr. Ure: Suppose that some hour in the day an operator with a call wire on which there are 50 or 60 subscribers gets half a dozen of them asking for a number, is it not your experience that she sometimes answers engaged in order to escape from her embarrassment?—No, that has never come under my notice. She had reported to the manager that a complaint was groundless, because the subscriber had failed to call off.

Mr. Salvesen: If the plugs come out of the jacks either by being knocked out by mistake, or in any other way, a conversation would be cut off?—Yes; but that seldom or never happens.

So that if conversations are cut off in the middle, it can only be by the operator wilfully and carelessly withdrawing the plug?—No operator would do such a thing. It never occurs, so far as I am aware.

The Commissioner: Two suggestions have been made in the course of the evidence. The first is that sometimes very unreasonable subscribers who are very impatient, have shouted again and again to the operators through the wires, and sometimes use rude language; and it is said that the operators occasionally take the change out of these gentlemen by refusing to put them in connection, by saying that the number wanted is engaged. What do you say to that?—No operator would do so.

You have seen nothing of that kind in your experience?—Nothing.

The other suggestion is that some subscribers who wish to get a preference over others will send a pair of gloves to the operator in charge of their line. Have you ever discovered anything of that kind?—No.

You have not had any experience of it as an operator or superintendent, or anything of that kind?—No.

Miss Jean B Filshill, examined by Mr. John Wilson, stated that she was superintendent for outside exchanges. She had held that position since December last. Previously she was for 2½ years chief operators' clerk, and attended to the chief operators' instruments in the Royal Exchange. During that time part of her duty was to receive verbal complaints by subscribers made by telephone. A great many of these complaints were received.

What have you to say about who was responsible for the complaints?—I decidedly say that the subscribers themselves in almost every instance neglecting to call off after finishing a conversation. This was a frequent occurrence. When the answer "engaged" was given, in many cases the person wanted was actually speaking. There were many subscribers who were constantly engaged from morning till night.

The Commissioner: If two subscribers are holding a conversation, is it necessary for both to call off?—Only the calling subscriber. When the calling subscriber neglected to call off, both the subscribers who had been in conversation remained practically "engaged." She had no hesitation in saying that many complaints were due to this cause. There were four superintendents in the Royal Exchange, whose duty it was to deal with such complaints. The company did everything in their power to educate subscribers in the habit of attending to this matter of calling off. Regulation cards were also given to subscribers. The operators were also provided with a set of rules. It was far easier for an operator to make a communication when possible, than to say a wire was engaged when it was not. If a wire was out of order, that would account for noises being heard. Such complaints were frequent after storms. All the subscribers were not unreasonable.

Are there some who proceed to argument and abuse?—In many cases they proceed to argument. Very many more connections could be made if the call wire was simply used properly, and subscribers did not argue with each other. In that case the operator could not hear what they were saying.

In all your experience, and as the result of all your inquiries, have you ever found a single case of one of the operators having represented that a number was engaged when there was no justification for her saying so?—I have not.

It was suggested that on some occasions subscribers had been rung off before they completed their conversation?—I cannot explain that, because there is no ringing off in connection with the system. We call off. From the fact that ringing off is mentioned, I should infer that it was in connection with a trunk line, where there is a system of ringing off.

Might an operator by mistake interfere in a conversation?—By mistake she might pull out a wrong plug, but that is most exceptional.

The Commissioner: Might not a button on her sleeve do it?—I think not.

Mr. Wilson: A mistake of this kind practically never happens?—Never. Continuing, witness said that she had heard buzzing sounds on the wire. She attributed that to the noise of the underground railway. Sometimes the buzzing occurred just when the trains were passing through the tunnel.

Have the company made any provision for dealing with wires out of order?—There is a break down board, and if a fault cannot be put right within a short time, I understand the subscribers are connected to this board temporarily.

Is there any doubt that the unfortunate misuse by subscribers of the call wire occasions a great deal of the difficulty in getting connection?—No doubt whatever.

Is it your view just now that there is any need in the company's service for more operators?—I would not say for more operators, but I say that one or two of the call wires may be too busy. But I always find the operators able to take all the calls. In these busy instances if subscribers used the telephone properly so much harm would not arise from their being busy. The oldest operators are put in charge of these busy wires.

By Mr. Ure: At present three instruments were kept going with subscribers complaining about inabiltiy to get communications. If an operator found a wire engaged for a considerable length of time—half an hour or an hour—it was her duty to ascertain whether or not the calling subscriber had omitted to call off. She called the attention of the superintendent to the matter. Indistinctness and noises were due to induction.

Do the operators sometimes become exhausted before the day's work is over on a line with 40, 50, or 60 subscribers?—Sometimes we have operators in hysterics through the behaviour of the subscribers on the wires.

Does that often occur?—We have had it frequently.

Are there some call wires upon which you have 40 or 50 busy men as subscribers?—Not 40 or 50 busy subscribers. There may be a number of busy subscribers. An operator can manage 50 quite well if she is competent.

And has a cool head.

Are there certain hours of the day when the demands on the operator are very much greater than others?—Yes; about half-past 10 and a quarter to 12 are the busiest parts of the morning, and three till four in the afternoon.

By Mr. Salvesen: Operators were engaged when about 16 years of age. The average age was 18 or 19 years. There were frequent changes in the staff. There had been a good deal of promotion within the past two years.

By Mr. Wilson: Something like 35 operators went over to the Post Office when they took over the trunk lines. When the girls were engaged by the National Company they were put through a course of training—a sort of apprenticeship.

By Mr. Wilson: The subscribers used bad language, swearing and abusing the operator because they could not get connections, generally because they were engaged.

They have no mercy under those circumstances?—Sometimes not.

By the Commissioner: It happened very seldom that one subscriber was put into communication with two subscribers at the same time. There had been dismissals of operators for speaking rudely over the call wire, but she did not know of dismissals for carelessness.

Robert Gallacher, who had been fitter for 2 years and inspector for 4½ years, and was now telephone inspector in the employment of the National Telephone Company, gave evidence showing that the cause of much of the indistinctness of hearing was caused by the subscribers abusing the instruments, and putting them out of order by external violence. In a good many cases subscribers omitted to place the phone on the hooked switch after speaking, with the result that the bell was cut out of circuit and the battery ran down.

By Mr. Ure:—The usual fault which he found when an instrument was out of order was that it had been put out of order through the subscriber poking pencils into them. It was very often the case that he found complaints groundless. When he found that an instrument had been maltreated he pointed it out to the subscriber at the time, but in many cases he would not answer. There was a very bad case of maltreatment at the Clyde Trust, which he reported to the manager. In a great many cases he had found the cord broken, through the subscriber leaving the receiver off the hook switch.

William Edward L. Gaine, the general manager and solicitor of the National Telephone Company, was examined. He gave a history of the introduction of telephony into this country, and explained how the Postmaster-General restricted the original license which he granted and took over the trunk wires under the Telegraph Act of 1892. Prior to the issue of the Treasury minute on the subject, the Telephone Company had promoted bills in Parliament with the view of obtaining statutory powers to run wires under and over ground, but the Government opposed them on the ground that the company, being the licensee of the Postmaster-General, ought not to have independent statutory powers, but that whatever powers were conferred should be conferred through the Postmaster-General, with the view of the State keeping its control. The Act of 1892 only operated, so to speak, to clothe the company with the powers of the Postmaster-General. Notwithstanding the delegation, the licensee may not in any urban disteict in England or burgh in Scotland exercise its powers without first obtaining the general cousent of the local authority. The company were not entitled to open streets without the consent of the streets authority, and from their decision there was no appeal. In Glasgow the streets authority was the Corporation. The telephone system had developed enormously.

With the development of the trunk service and scientific improvements in the plant, did the necessity of adopting the twin-wire or metallic circuit gradually become apparent to the company?—Yes, Upon the completi n or the agreement with the Government and the transference to them of the trunk wire part of the system, the National Company opened negotiations with towns throughout the kingdom for the purpose of getting their consent in terms of Section 5 of the Telegraph Act, 1892, with the view of reconstructing the system of the company underground on the twin-wire or metallic principle, in place of the overhead existing wire. As the result of these negotiations, agreements had been made with a large number of cities and towns, including Liverpool, Manchester, Birmingham, Leeds, Belfast, Bristol, Bradford, Nottingham, Leicester, Portsmouth, Dundee, Blackburn, Bolton, Norwich, Birkenhead, Halifax, Wolverhampton, Cork, Walsall, Southampton, Coventry, Hastings, Bath, Bootle, Stockton, Eastbourne and Windsor. These agreements varied materially in the conditions imposed upon the company. The agreement with the Liverpool Corporation was the most onerous one against the company. It provided, among other things, that any works involving interference with the streets might be executed by the Corporation themselves or through a contractor at the expense of the company, or by the company under the supervision of the Corporation; that the company was not to increase its present rates of subscription in the telephone area; that all citizens of Liverpool were to be entitled to demand telephone service without preference; that if any works of the company under the streets at any time, in the opinion of the engineer of the city of Liverpool, required alteration or removal, the company was under obligation to remove or alter them as required; the company was to have no claim upon the Corporation in the nature of damages for interference with or alteration of the plant of the company under its streets; and no monopoly of the streets was intended to be conferred upon the company. That agreement having been completed, the company was now engaged in the construction of an under-street metallic circuit in Liverpool. In a number of towns an underground system had been completed. In addition to the towns he had mentioned there was the case of London, in which they had got the consent of the London County Council to an under-street double-circuit wire system. The effect would be to assimilate the position of the company with that of the Postmaster-General, and therefore they had the right of appeal to a County Court judge, and ultimately to the Railway Commissioners if the street authority did not let them get under the streets. In Huddersfield also they had been clothed with the powers of the Postmaster-General. The company had incurred very large outlay in effecting the change from the overhead system in places where that was in operation. The most recent case was Manchester, where the cost of transferring from the overhead to the underground was upwards of £80,000. The necessary steps were being taken in regard to London. It was a very large undertaking; larger, in fact, than one liked to contemplate. In London there had been a double overhead metallic system, but it was the intention of the company to put it underground. London was very differently situated to either Glasgow or any other city. The enormous area and the complexity of the system had necessitated a very large number of exchanges. There was not the same kind of concentration as in Glasgow. It approached it, however, in the centre of the city, but even there there were four exchanges in that square mile. In London the company had expended £300,000 on the overhead system, and now they would have to tear it all down, and incur nearly the same cost in placing it underground. It was obvious that to make the system as complete as it could be an underground metallic system was required. The development of the science of telephony within the last few years had made the underground system possible as an efficient system. Witness then read the correspondence which he had with the Corporation of Glasgow, in which their co-operation had been asked to put the wires underground. The final answer to the request had been received on February 23, 1897, when the Clerk of Police wrote: "I have now to inform you that after careful consideration the Corporation Police Department have resolved that the request of the National Telephone Company for wayleave to put down underground wires in the streets be refused." Had the consent of the Corporation been given, the company would have at once proceeded with the work, or provided the money for an underground metallic system. Witness said he had had prepared a series of tables showing the nature and extent of the company's business, indicating its Imperial as distinguished from its local character. The first one showed the increase in subscribers which had taken place during the past seven years in such towns as Glasgow, Edinburgh, Aberdeen, Birmingham, Manchester and Liverpool. It showed that there was a very large increase in Glasgow in comparison with other large towns, notwithstanding alleged inefficiency, &c. The total increase was 3,450. While the total number of lines in 1890 was 2,652, it was now 6,102. These were the lines in actual use. The increase had been larger in Glasgow than in any other city, except Liverpool. Out of a total of 86,552 exchange lines, 53,663 were now practically underground metallic circuits, or 64 per cent. With regard to 19,912, or 23 per cent., so far as the switch boards were concorned, they were capable of being worked on metallic circuit. The average number of faults extracted from the company's fault-book for the year 30th June, 1897, were 3·02 per line, while the average number of messages was 4,897 per line. He submitted another table, showing that the annual number of effective calls, based on the actual calls for the week ending 15th April, 1897, in Glasgow was 12,071,332. As each call involved two messages, the total number of messages passing over the Glasgow wires annually was 24,142,664. This worked out at a cost per message of ·57 of a penny, taking the whole revenue in Glasgow. The total number of inland telegrams for the United Kingdom, according to the report of the Postmaster-General for the year ended March, 1896, was 72 millions, so that in Glasgow the number of telephone messages was more than one-third of the total number of the inland telegrams of the Kingdom. Another table which he put in had reference to the whole Kingdom, and showed that the price was ·54 of a penny, against ·57 of a penny in Glasgow. Another table which he put in showed the principles upon which the company's charges were based. There was a tariff for the Metropolis, where special difficulties had to be contended with; a tariff for the great towns, such as Glasgow, Liverpool, and Manchester; a tariff for the towns of medium size, and a tariff for small outlying places, such as Elgin, Wick, and Oban. He put in another table showing the number of messages daily passing through some of the more important exchanges throughout the country. The first one on the list was the Royal Exchange, Glasgow, where the number of the subscriber's lines was 3,702. The number of messages per day, including Sundays, but exclusive of the trunk messages, was 53,345. That gave an average of 14 messages, or seven calls per subscriber, and worked out at ·49 of a penny. On 15th September last a return was prepared, and out of a total of 161,552 messages that passed over the wires on that day 128,448 went through under half a minute, 13,360 went through under a minute, and then they got delays, which, however, were comparatively small. He had not taken any calculation over five minutes. Put broadly, the cost of the service to subscribers, taking the system all over, was about ¼d. per message. A great deal had been said about rates and charges in other countries. Telephone business in this country was carried on under absolutely different conditions from those which operate in any other country that he was aware of. Wherever the telephone system was in the hands of the State no royalty would be payable. In this country the National Company paid a royalty of 10 per cent. upon the gross receipts, and at the present time that represented an annual charge of upwards of £100,000. Under the agreement with the Post Office, the company's tenure was limited to December 31st, 1911. The company had no right, statutory or contractual, to demand anything from the Government at that date. It was well known that labour, rent, rates and taxes in this country were much higher proportionately than in a great many of the countries in Europe with which the system here had been so frequently compared. Seventy per cent. of the cost of carrying on the business was for labour. He regarded £1 per annum as a very low estimate of the terminal charges that subscribers to a Corporation system in Glasgow would require to pay to the National Company. It was a ridiculous proposition to put

forward that the National Company would open its doors to a rival system. It was of no value to cite the case of Stockholm, because the Government there were in the position of being masters of the situation.

If the National Company exacted payment of terminals, have you any doubt that the effect would be that the Glasgow Corporation could only communicate with your system in other towns on payment of the terminals?—They could only communicate with our subscribers in other towns if they paid the terminals, but not only so, they could not communicate at all with our subscribers in the Glasgow area, and therefore any Glasgow subscriber desiring to have full advantage of the telephone service would have to join both systems. That had been the invariable experience. It was so in Manchester when the Mutual started there. It is so to-day in Newcastle and Cardiff, where they have rival systems.

The suggestion has been made that the company would be very foolish to charge terminal fees?—I think the company would be extremely foolish if it did not do so. In the nature of things the Corporation of Glasgow would take years to build up a system anything like that which exists in the hands of the National Company. The company have spread over the length and breadth of the land 100,000 and more subscribers. Why it should open its doors to a rival system, and let the subscribers of that system have access to all these subscribers, I cannot see. The company, to protect its interests, would be compelled to, and would, charge the terminal fees. Continuing, the witness said that the present system in Glasgow was not inefficient. Of course, inefficiency was a very relative term. The statistics he had put in, and the enormous use that was being made of the service, showed that it was not an inefficient service. If it was suggested whether or not the company could make it a much better service, he said yes, and that had been the object and wish and intention of the company for a long time. There had been very great development during the last few years in long distance telephony and so on, and with that development had come the necessity for this improvement, especially of placing the wires underground. When the trunk wire agreement was signed in 1896, with his consent 35 of the most skilled operators in the Royal Exchange, Glasgow, were transferred to the Post Office. He was bound to say that there had been some difficulty in filling their places, and the transfer had had a serious effect on the local service. The number of subscribers on a call wire was regulated from time to time by the switch-room inspectors, of whom there were a large number on duty. Criticising Mr. Bennett's estimate for a telephone service for Glasgow, he said it was somewhat difficult for him to understand how he, with a staff of 44, down to the point where he begins "the chief operator a lady," would be able to do what they were told the Telephone Company did badly with a staff of 89. No provision was made in the estimate for an outside or line staff. With regard to operators, in Glasgow the number of subscribers assigned to an operator was fewer than in any other place he knew. The number in Stockholm was 64, while in Glasgow the average was 48·39.

Mr. Ure: You said the company did not think the service in Glasgow was inefficient?—I said relatively, no.

Relative to what?—Relative to the service on the Continent, and in America generally, where there are mixed systems; some are metallic circuit, and some are single wire.

The average number of complaints per subscriber's line in Glasgow is 3·02, with 4,897 subscribers; while in Birmingham the average is decimal 83, with 5,969 subscribers; relatively to Birmingham, is Glasgow efficient or inefficient?—Efficient. When you come to percentages such as these, the thing is very small indeed. Relatively, the service is commercially efficient, but it is not so good as it could be made, and as the company will make it, if they are given the power to do so.

When you found that you were receiving numerous complaints in Glasgow, did you take any means to ascertain the opinion of your subscribers?—We knew perfectly well what the condition of things was. That was our business. We knew what we could do and what we were doing.

When you are told that out of 4,183 persons who were consulted on the subject by circular 2,869 returned answers stating that they did not consider that it was efficient, while 146 did not express dissatisfaction, do you still say that the service in Glasgow is efficient relatively?—Yes, I do. If you send out a letter to subscribers who enjoy any public service, nine out of ten of them will tell you that they are not satisfied.

Suppose that the Corporation refuse the company leave to go beneath the streets of Glasgow, will your company then set about the construction of a metallic circuit system overhead?—I can't say yes or no. If we were to do it overhead, I am certain it is only throwing away money, because it would all have to be torn down in a very short time and put underground, and I think it will be for the board of directors of the company to consider whether in such an event Parliament ought not to determine the question.

Do you or do you not propose in the same event to construct a metallic circuit overhead, or to improve in any way the existing system?—The existing system, short of being made into a metallic circuit system, is as good as it can be made. There are many defects, defects which are inherent to every telephone service which is not a metallic circuit one. It is good plant, and it is a good service.

Then, in your opinion, the present service is as good as you can make any overhead single-wire system?—I don't say so. If the single-wire system is taken as a whole, it is well constructed and well maintained, and it is a good and efficient service for what it is worth up to a point. Witness then described the defects which he thought pertained to an overhead metallic circuit system, and the good points of an underground system.

The inquiry was then adjourned until next morning, at a quarter past ten o'clock.

(To be continued.)

EFFICIENCY OF COMBUSTION IN A BOILER FURNACE.

(Concluded from page 506.)

Mr. Hale next considers the various systems of firing known as *alternate*, spreading, and coking firings. The alternate system, when one side of a furnace is covered with coal and the gases given off are mixed with the excess of air coming through the other side suggests itself as sound. When spreading is thinly done it closely resembles the alternate method, but in this case the firing is on patches and the remaining spaces let through the needed excess of air. Such firing, if properly carried out, is better than alternate firing, but complete spreading is obviously undesirable.

In boilers with bridge walls, the coking system, which consists in placing a bank of green fuel at the dead plate and pushing it back when partially deprived of its gases, has the advantage of presenting a clear fire over the length of which the gases from the fuel on the dead plate must pass, and they are thus first heated and mixed with a supply of heated air that has come through the fire and then burned at the bridge. In water-tube boilers of ordinary setting the coking system is useless, and we had almost said no system of firing bituminous fuel can be correct with so unscientific a setting. If any system has an advantage in such a furnace it should be the sprinkling system.

The coking system has the one disadvantage that the rear portion of the grate is not easy to be seen by the fireman. "Little and often" has been the word for good firemen, meaning frequent charges of small amount each. Mr. Hale supports this view but he does not point out how the frequent opening of the fire-door may effect more harm than the firing effects good by the very large amount of air admitted at such times to cool the plates. If at every opening of the fire-door the dampers could be closed until the draught was almost stopped, and the firing could be done quickly no great harm might perhaps result. It is just this that the sprinkling mechanical stoker aims to secure, and the sprinkling stoker up to a point is an ideal machine, and only fails because it causes dust and is not yet perfect in its sprinkling devices, both shovels and fans often failing to give a correct and even sprinkling of fuel.

When Mr. Hale proceeds to discuss thick and thin fires, we can hardly agree with him. True, a thick fire is apt to cut down the power of a boiler, but we are decidedly of opinion that, as a rule, it is good practice to work a boiler to its maximum draught capacity and to run the fires as thick as the draught can manage, shortening the grate to the length needful. Mr. Hale, however, does point out that a thick fire will respond to a sudden call for steam better than a thin one, for it can be opened up and put into a condition of more rapid combustion, and has a reserve of fuel ready for this. He looks on a thick fire as an incentive to the fireman to neglect his work, but we have known a fireman who worked a thick fire to take matters very easily and still find time to keep things well up to the mark.

In advising a thin fire to allow excess of air to pass through for the combustion of the gases above the fire, we think Mr. Hale is advising a risky practice. It is so difficult to keep a thin fire properly uniform. Some air admitted above the fuel is allowed to be necessary, and the door is, of all places, generally the best point for this air to enter, as more time is given for its heating and combustion while admission among the tubes of a tubular boiler is sheer waste, for the gases are too cool then to take fire. Air should be as hot as possible when admitted, and a hot blast under the grate is a help, but is apt to cause the grates to burn out. Steam admission is not approved, and it is not even allowed to have any good effect on the combustion of carbonic oxide which will only burn when in the presence of hydrogen or water. We are dubious on this point. Even a bituminous fire fully charged with hydrocarbons will burst into flame on the provocation of the merest dribble of steam in a way that is not explicable on the score of any induced draught.

Of course, where steam combines to form water gas with the fuel and the gas does not burn, there will be great loss. The report, however, condemns water *in toto*. Brickwork in the furnace or in the combustion chamber is well spoken of, and we have long urged its use as a means of retaining temperature long enough to ensure perfect combustion, but, of course, the idea may be overdone. When applied as in the locomotive, a brick arch cannot fail to be an advantage. It is the one means to secure smokelessness that is certain, for it acts both as a regenerator and as a directer of the flow of gas in the furnace, and compels all the products of combustion to go the right way to the tubes, over the fire-bed, and past the air inlet at the fire-door.

The down draught grate is well spoken of as a system for good combustion, but it needs a strong draught and a high rate of combustion, on the upper grate, per square foot. The fireman, moreover, must work the fuel about on the upper grate, so that the fire is usually doing its maximum, and a sudden call is not so promptly responded to as by a fire in which the fuel is filmed over with ash, the removal of which by disturbance will at once quicken the combustion.

The same remarks apply to mechanical stokers which have constantly moved fires, and are never so dirty as a hand-fired stationary grate. The grates can thus be smaller and the combustion as high, but a large amount of loss goes on through the bars, and this ought to be re-fired. Steady work seems certainly to be best for mechanical stoking, or otherwise the air regulation becomes difficult. The softer coals will show the biggest saving where machine stoked, because of their hydro-carbons and the wide variation in these when fired by hand which demands as wide a variation in air supply. The air supply is apt to run to excess with such coals, and then to be short at firing, and machine firing ought to cure this.

We all know the fiasco which gas firing has proved, and we observe that Mr. Hale says gas firing ought to show higher results than solid

fuel when there is suitable firebrick in the combustion chamber. It is evident to us that gas firing ought to be economical, but so much heat is loss in producing the gas that it is very difficult to make this up by any subsequent economy. This loss to begin with is 10 to 20 per cent. Dust fuel, fired as spray, resembles gas, but its fault is pointed out as the dust which collects in the flues. The fault of both gas and dust without fire brick surfaces is the loss of radiant heat effect in the boiler. It certainly would seem that economy of combustion demands radiation of heat direct from the incandescent fuel upon the plates. Gas firing is all very well in a limited way, but the proper use of gas is as the agent for power production in internal combustion engines.

Mr. Hale can only say in regard to the many devices such as down draught grates, mechanical stokers, and numerous other patented devices, that many of them will give better results with moderately skilled firemen than are to be obtained with ordinary firemen and ordinary grates, and it is probable, but not proven, that ordinary firemen will obtain better results than would ordinary firemen on ordinary grates. This is not very strong recommendation to act upon in spending money upon patented so-called improvements. Indeed ar too many boiler improvement devices are sheer useless rubbish or

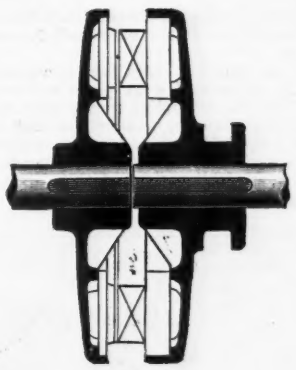


Fig. 2.

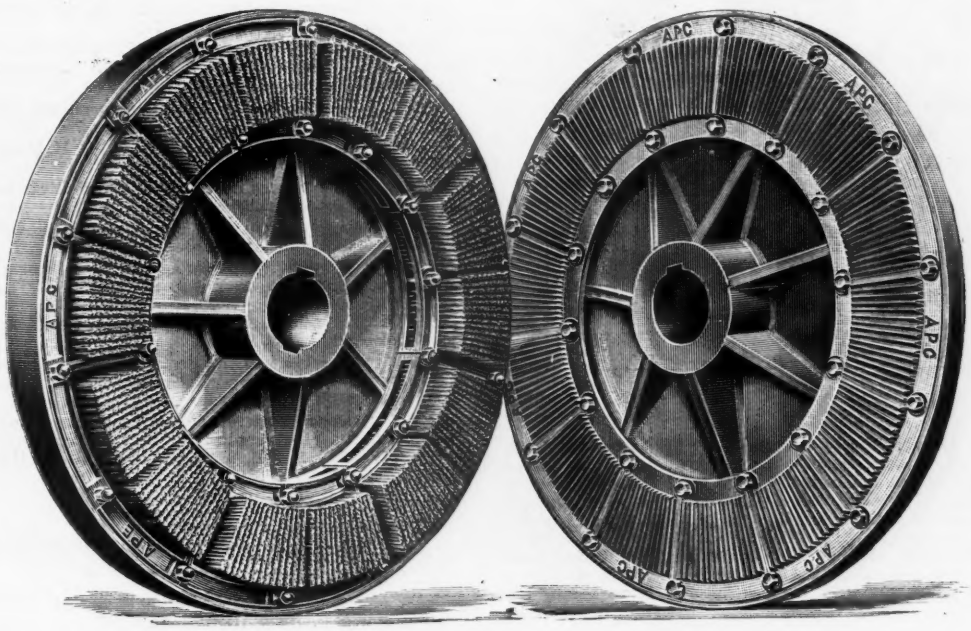


Fig. 1.

if not rubbish are not worth their cost. Numerous boilers have been badly spoiled by attaching to them so-called patents that were not worth scrap iron value. Altogether, Mr. Hale's report is a valuable one in bringing together a good deal of technical knowledge on the subject with which it deals. It might just as well have been written by an Englishman on English practice so exactly on the whole are the conclusions, drawn by Mr. Hale, on a parallel with practice on this side.

ELASTIC CLUTCH.

The elastic clutch or coupling (Snyer's patent) of which we give several illustrations, consists principally of two parts: One part carries a number of flat steel wire brushes, while upon the other are secured a series of finely serrated or toothed plates. This device is said to be equally good as a pulley clutch, or as a coupling. Indeed, we understand that the sole licensees for this country—Messrs. Cowlishaw, Walker & Co., Limited, of Etruria, Stoke-on-Trent—supply more pulleys than couplings. From the many advantages claimed we quote a few. There is stated to be total absence of shock, whether in running or starting the machine, and also it is claimed that by the use of these clutches one is enabled to start or stop machinery at a very high speed without slowing down the engine. To illustrate this, we may mention that at Messrs. Cockerill's (Seraing) Works two clutches of 250 H.P. each, running at 200 revolutions per minute, which transmit power to dynamos lighting the whole of the premises, are started with the engine at full speed. The clutches slip for about 5 seconds, when they bring the large dynamos up to full speed. As the steel brushes take the effect of sudden snocks and strains the wear and tear of machinery and belting is lessened. Owing, also, to the elasticity of driving, and to the clutches being made only slightly in excess of the specified power, thus allowing the clutch to slip if any considerable additional strain is thrown upon it, there is less likelihood of breakdown, for the clutch acts in the same way as the safety valve of a steam boiler. The possibility of the clutch creeping into gear is *nil*, as when disengaged the parts are said to run quite clear of each other. We are informed that

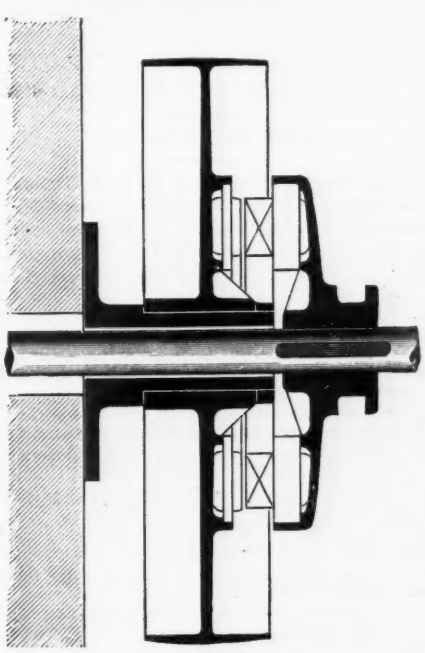


Fig. 3.

the amount of power to be transmitted can be varied at will (decreasingly) in the same clutch, by decreasing the depth of engagement of the bristles with the separated plates.

Any machine requiring frequent stopping and starting (such as a

lathe), can be driven through this clutch direct from the main shafting, so dispensing with the usual countershaft, fast and loose pulleys, overhead belts, &c.

These clutches are stated to have been in constant use under the Belgian patent for upwards of seven years without showing undue signs of wear. They can be applied to any new or existing wheels or pulleys direct on to machines, or simply as shaft couplers.

Messrs. Ernest Scott & Mountain, Limited, of Newcastle-on-Tyne, after employing a good many of the clutches, find them very suitable for electrical work, as enabling the load to be gradually thrown on

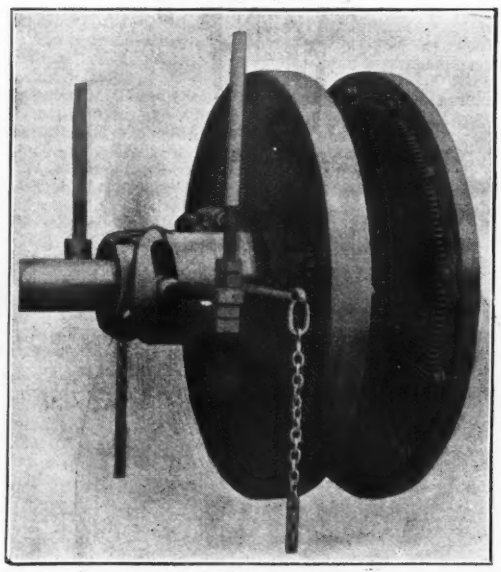


Fig. 4.

without undue shock. Fig. 1 is a general view; fig. 2 shows the clutch used as a shaft coupling; fig. 3 shows the clutch employed as a loose pulley, instead of fast and loose, the pulley being carried on a sleeve (fastened to a wall or beam) clear of the shaft. With this arrangement the weight of pulley and pull of the belt is taken off the shaft. Fig. 4 is an illustration of the firm's patent slot engaging gear as applied to the clutch. It is an effective method of producing lateral motion, and as one of the vertical arms is secured to the roof, floor, or wall, it requires very little fixing. The gear is worked by the hanging chains.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1897.

[*Compiled expressly for this journal by* W. P. Thompson & Co., *Electrical Patent Agents*, 322, *High Holborn, London, W.C., to whom all inquiries should be addressed.*]

22,657. "An improved switch for large numbers of electric circuits." H. J. Eck and H. King-Smith. Dated October 4th.

22,693. "Improvements in oval incandescent filament lamps." W. G. Potter. Dated October 4th.

22 717. "Improvements in interruptors for electrical circuits, more particularly applicable to induction coils." C. E. S. Phillips. Dated October 4th.

22,728. "Improvements in connection with stowing and handling submarine cables on board ship." C. S. Snell. Dated October 4th.

22,729. "Improvements in connection with submarine cable laying appliances." C. S. Snell. Dated October 4th.

22,738. "Improvements in or connected with telephonic apparatus." G. Thomas-Davies. Dated October 4th.

22,772. "Improvements in dynamo-electric machines." M. E. Thompson. Dated October 5th. (*Complete.*)

22,796. "Improved wall connection for electric lighting." J. Peschek. Dated October 5th.

22,800. "Improvements in electrical apparatus for use in dental surgery and other electro-surgical treatments." W. E. Dow. Dated October 5th. (*Complete.*)

22,806. "Improvements in and relating to alternating current dynamo-electric generators." C. S. Bradley. Dated October 5th. (*Complete.*)

22,807. "Improvements in and relating to alternating current electromotors." C. S. Bradley. Dated October 5th. (*Complete.*)

22,844. "Improvements in switches for electric railways." H. H. Lake. (Detroit Automatic Switch Company, Limited, United States.) Dated October 5th. (*Complete.*)

22,845. "Improvements in and relating to junction boxes for use in electric distribution systems." J. Cloos. (Date applied for under Patents, &c, Act, 1883, Sec. 103, March 6th, 1897, being date of application in United States.) Dated October 5th. (*Complete.*)

22,849. "Electric signalling apparatus." S. Szubert. Dated October 5th. (*Complete.*)

22,851. "Improvements in electrical measuring instruments." W. P. Thompson. (O. B. Shallenberger, United States.) Dated October 5th.

22,852. "Improvements in phase adjusting and regulating methods and means for alternating current apparatus." R. Belfield. (Egbert M. Tingley and O. B. Shallenberger, United States.) Dated October 5th.

22,895. "Improvements in cord-grips for electric lamp holders." A. Watson. Dated October 6th.

22,939. "Improvements in connection with electric lamps and apparatus for signalling and advertising purposes." C. E. Kelway. Dated October 6th.

22,978. "Improved fusible cut-out for electric lighting and the like." J. Peschek. Dated October 7th.

23,003. "An improvement in electric plug contacts." H. C. Gover, M. S. Blair, and C. F. Proctor. Dated October 7th. (*Complete.*)

23,057. "Improvements in and relating to electric railways." E. C. Crocker and E. C. Howe. Dated October 7th. (*Complete.*)

23,097. "Electrical conductor or cable." G. H. Nisbett. Dated October 8th.

23,098. "Conduits for underground electrical conductors." G. H. Nisbett. Dated October 8th.

23,099. "Improvements in or connected with arc light electrical generators." J. Swinburne. Dated October 8th.

23,123. "An electrolyte for carbon and zinc elements suitable for lighting and other purposes." J. S. Johansen. Dated October 8th. (*Complete.*)

23,192. "A dynamo-electric machine and motor." A. H. Finlay. Dated October 9th.

23,239. "Improvements in automatic telephone exchanges." W. P. Thompson. (The Strowger Telephone Exchange, United States.) Dated October 9th. (*Complete.*)

23,260. "Improvements in automatic magnetic circuit breakers." W. M. Scott. (Date applied for under Patents, &c., Act, 1883, Sec. 103, 17th March, 1897, being date of application United States.) Dated October 9th. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., *price, post free,* 8½*d.* (*in stamps*).]

1896.

9,480. "Improvements in electrical contacting devices for subways or conduits." A. S. Kratz, W. P. Allen and O. S. Kelly. Dated May 5th, 1896. Relates to collectors for use in conduit systems. The contacts are carried by spring arms which slide through the insulation in the shank, and are connected to a crosshead attached by springs to lugs on the shank. A second crosshead, attached by springs to a casing carries the shank. On pulling up the first crosshead the spring arms are first retracted and the shank is then lifted out of the slot. 1 claim.

9,531. "Improvements in dynamo-electric machines." J. Devonshire. (C. P. Steinmetz, United States.) Dated May 5th, 1896. Relates to dynamos of the inductor type in which the armature coils are arranged upon the field poles, and currents are produced by the rotation of an iron mass in the vicinity thereof. The field poles are extended circumferentially and furnished with projections on which the armature coils are wound in such a manner that alternate coils are adjacent to the inductor. The inductor is composed of sectors of different polarity, which changes in passing from one field to another 6 claims.

10,124. "Improvements in systems of distribution of alternating electric currents." J. Devonshire. (C. P. Steinmetz, United States). Dated May 12th, 1896. Relates to polyphase distribution and to the arrangement of an "equalising" or "balancing" wire. In a three phase system shewn in the drawings, the primaries of the transformer are connected in △ and the secondaries in Y with the balancing wire connected to the middle point. The balancing wire is thus used in the secondary system only. 2 claims.

10,272. "Improvements in dynamo-electric machines." H. T. Harrison. Dated May 13th, 1896. Relates to alternating current generators of the inductor type. The field magnet of the machine is composed of two parts—a stationary part wound with an annular exciting coil and having an annular rim or extension, and a rotating part or inductor carrying radial poles. On the inner side of the rim is secured a laminated iron ring, against which the armature coils are fixed by means of insulating rings and curved strips. These rings and strips also serve to carry the screws and connections for joining up the armature coils. There are twice as many armature coils as there are polar projections on the inductor. 2 claims.